JPRS-UST-95-012
9 March 1995

FOREIGN BROADCAST INFORMATION SERVICE

JPRS Report

The Foreign Broadcast Information Service requests Department of Defense subscribers to see the notice inside for information regarding their subscriptions.

Science & Technology

Central Eurasia

ATTENTION!

DEPARTMENT OF DEFENSE SUBSCRIBERS

Effective 15 April 1995, DIA will no longer disseminate FBIS reports to the DOD community, and all current DOD hardcopy subscriptions to these reports will be stopped.

Concurrent with the DIA action, FBIS is conducting a revalidation of all subscriptions as part of FBIS' gradual transition from hardcopy to softcopy products. Consequently, any DOD component with a continuing requirement for hardcopy reports will have to contact FBIS by 1 April 1995 to maintain its current subscriptions. DOD customers may send their requests for subscriptions electronically to RUCWAAB/FBIS Reston Va//Customer Service//, by fax to 703-733-6042, or by mail to P.O. Box 2604, Washington, D.C. 20013. In notifying FBIS that they wish to maintain subscriptions, DOD subscribers should use the format below. Please include in the comments section a brief statement on how you use FBIS hardcopy products. Questions about revalidation of subscriptions may be directed to FBIS Customer Service Representatives at (202) 338-6735 or 1-800-205-8615.

Branch of Service: _____ Unit: _____
Please indicate primary unit function: ____ Intelligence ____ Operations
____ Support ____ Library

Name: _____
Tel # : _____ Fax No: _____
E-Mail Address: _____

Postal Address: _____
_____
_____
_____

Customer# (above, and to the right, of zipcode on back of report) _____

Report Title (s): _____
_____
_____

Comments: _____
_____
_____

Science & Technology
Central Eurasia

JPRS-UST-95-012 9 March 1995

CONTENTS

LIFE SCIENCES

Division of Civilian, Military Authority at Baykonur Viewed

957A0117B Moscow SEGODNYA in Russian 29 Dec 94 p 9

[Article by Mikhail Chernov: "The Baykonur Layout Now Resembles a Chart of Staff Exercises. The 'Reds' of the Military Space Forces and the 'Blues' of the RSA Mark Their Spheres of Influence"]

[FBIS Translated Text] The enormous Baykonur facility has finally been divided up. This was reported on 27 December at a press conference held by Boris Ostroumov, deputy general director of the Russian Space Agency [RSA]. Graphic evidence of this restructuring is the layout of the cosmodrome, where all its launch pads, residential zones and other structures have been marked in two colors: everything which falls in the sphere of responsibility of the Military Space Forces [MSF]—in red, all that in the sphere of the RSA—in blue.

Baykonur today has 15 launch pads and 11 assembly-test buildings. Thirty-three boosters and 33 space vehicles can be brought in to the cosmodrome for storage and subsequent assembly, checking and launch. Baykonur is the city of Leninsk with 60,000 inhabitants, 1,300 kilometers of roads and 470 kilometers of railroad tracks. There is the "Yubileynyy" complex for the launch of the Burans with a unique landing strip for the Russian shuttles and there is the "Krayniy" airfield, through which Baykonur communicates with the outside world. The fixed capital of the cosmodrome amounts to about 15 trillion rubles.

The MSF have taken on themselves responsibility for operation of a part of the Proton complex and the launch facilities for the Zenit boosters. The military also are responsible for providing communal services to Leninsk and the "Krayniy" airfield.

The RSA is left the launch pads for the Soyuzes, Buran and Energiya, some of the Proton launches and other facilities. All together they account for about 60 percent of the amount of capital investments in the cosmodrome. In addition to the RSA, seven so-called basic space enterprises, such as Energiya, NIIkhimmash and others, will make their contribution to maintenance of the mentioned facilities.

Among the somewhat less than 50 space launches carried out in Russia during 1994 almost 30 were from Baykonur. The percentage of civilian satellites is constantly increasing. All the manned launches also are taking place from Baykonur. Boris Ostroumov feels that all this indicates that the cosmodrome leased from Kazakhstan will long remain the principal spaceport of Russia. As he sees it, all the talk about "transfer of the center of gravity" to a different place should not be taken seriously.

Meanwhile, the shifting of funding priorities of both the MSF and the RSA is leading to situations which in any case at first glance are inconceivable. In Leninsk 40,000 inhabitants are Russians (for the most part military personnel and their families) and 10,000 are Kazakh citizens. Another 10,000 persons live in the "closed city" without passports: no one knows who these people are and what they do. The Russian Ministry of Defense, due to a money shortage, is unable to pay the salary of all the military personnel. The RSA and the "basic enterprises," also having no excess of money, nevertheless have been forced to "pay the upkeep" for 16,000 members of the Ministry of Defense contingent: 4,000 officers, 2,000 civilians and 10,000 soldiers. Otherwise, as they feel in the RSA, the entire facility left as a result of large-scale reductions of the military would simply be plundered. In addition, it is evident that other than the military no one would work at the cosmodrome for the money offered.

In the new year it is assumed that space activity in Russia will persist at the level of the past year. But financial problems most likely will remain as acute. The RSA from December 1993 through the current December, despite all the formidable decrees and resolutions of Russian authorities, received only a quarter of the promised sum—610 billion; 310 billion of this sum went for manned flights. With respect to earnings, including foreign exchange, they have been extremely modest. Russian-American cooperation brought in little money because 1994 for the most part was a "paper" year, that is, a period of coordination of different programs and projects, and the Americans do not make advance payments, paying only for completed work. The coming year, it is anticipated in the RSA, will be more successful in this respect because equipment for use in joint programs will begin to arrive at Baykonur from the United States. According to the understanding reached between Russia, the United States and Kazakhstan, the American equipment will be transported by air directly from the United States to Baykonur, bypassing customs control in all flight stages.

Neither the MSF nor the RSA will be concerned with matters relating to the lease payment for cosmodrome operation ($115 million annually). All financial problems relating to interrelations between Russia and Kazakhstan will be solved at the level of the ministers of finance or at a higher level. The fact that Kazakhstan owes Russia a sum exceeding a billion dollars will probably be taken into account. But in general the signing of the agreement between Russia and Kazakhstan on the leasing of Baykonur still does not mean solution of all the problems. It is necessary to prepare and examine at least 28 more documents making the signed agreements more specific. In the present stage Kazakhstan does not intend to intervene in the operating regime of the cosmodrome related to launches of satellites and manned ships and Russia is not obligated to coordinate its programs with Kazakhstan; this also includes international launches.

In addition to the divided property, a great many joint-use facilities remain at Baykonur: communications, water supply systems and much more. Under these conditions it is virtually impossible to overcome the "triumvirate." The overall direction of Baykonur

remains to the Russian military, and the civilian administration—Russian and Kazakh—will coordinate its actions with the people with shoulder straps.

Russian Expectations From Commercial Space Discussed

957A0117C Moscow SEGODNYA in Russian 19 Jan 95 p 9

[Article by Vladimir Sergeyev: "Space Expectations of Russia. Foreign Contracts Cover One-Quarter of Branch Needs"]

[FBIS Translated Text] The plan for launches of space rockets this year, prepared in response to the requests of military and space users, provides for an increase in their number by a factor of 1.5 in comparison with the past year.

During 1995 plans call for continuing programs for manned flights: three Soyuz TM spaceships (SS) (March, August, December), six Progress M cargo transport ships (CTS) (February, April, June, July, September, November) and two modules: Spektr (May) and Priroda (November) should be launched to the Mir orbital manned complex (OMC).

In February provision is made for approach of the American Discovery orbital station (OS) to the Mir OMC to within a distance of 10-15 meters. This maneuver will be a general rehearsal for the first docking of the Atlantis OS, planned for our complex in June, after which a second should follow in October.

In March the MSF has planned a launch from the Baykonur cosmodrome of a Soyuz-72 booster with the Soyuz TM-21 spaceship in which a crew made up of Vladimir Dezhurov, Gennadiy Strekalov and Norman Thagard (United States) is to be launched to the Mir OMS. And in August, in the next Soyuz TM, Yuriy Gidzenko, Sergey Avdeyev and a representative of the European Space Agency, the Swede Christer Fuglesang, will be sent into space. He, the first of the foreign astronauts, is to work in the Russian OMC for a record number of days—135. In June the crew of the 19th main expedition aboard the Mir will for the first time be transferred to the Atlantis OS. Over the course of a year the crews of the main expeditions on the Mir OMC should make 9 walks in open space (during the past year there were only two).

In 1995 intensive work also is to be done on the launch of unmanned satellites. Launches of communication satellites, including geostationary, will be continued by the MSF, not only for ensuring domestic needs (Gorizont, Ekspress, Gonets satellites), but also under a contract between the Russian AO Informkosmos and the American company Rimsat Ltd., for which one of two new-generation Ekspress satellites will be launched.

In February the MSF should launch the next Foton industrial satellite from Plesetsk (with participation of the ESA), as well as the scientific Bion and Koronas-F satellites. During the first quarter of the year plans also call for the launch from there of the Prognoz-M2 satellite under the Interbol program. All the scientific launches will be with broad international participation.

The first launch this year should be the launch of the Tsikada navigation satellite from Plesetsk on 24 January. Now urgent computations of the Russian Military Space Forces are laying preparations of a space vehicle and a Kosmos-3M booster by means of which together with our satellite two foreign subsatellites also are to be put into space: the American experimental communication satellite Falsat of Final Analysis Inc. and the Swedish scientific satellite ASTRID. Both the American and the Swedish vehicles should be put into orbit by a Russian booster for the first time. Contracts for this launch were signed by the aerospace association AKO Polet (Omsk), the builder of the Tsikada satellite and the light Kosmos-VM boosters.

On 28 March, also for the first time, the Russian light six-stage Start booster from the rocket test site at Plesetsk should put into orbit the Israeli satellite Gurvin-1 (Techsat), constructed by the Technion engineering institute in Haifa. Plans call for putting into orbit the next, third Indian satellite of the IRS (India Remote Sensing) series from the Baykonur cosmodrome. This same year a Proton-K booster for the first time will launch the Inmarsat-3 satellite of the International Marine Satellite Communication Organization. In general, however, in accordance with earlier concluded contracts, in 1996 only 12 foreign satellites should be launched from Baykonur into a geostationary orbit and 3 into low orbits. The execution of these launches will afford a possibility for earning about $650 million. However, this sum under the agreements and contracts will be only 25 percent of the needs of the space branch.

During 1995 plans call for completing deployment of the GLONASS national navigation system, put into on-line use during the past year. The beginning of joint use of this system and the similar American NAVSTAR (GPS) system in the interests of civilian users also is anticipated. Launches of satellites of the Okean-O and Resurs-F series are planned for remote sensing of the Earth.

This year plans also call for completion of tests of a whole series of new space systems.

The MSF is continuing launches of military satellites from both Plesetsk and Baykonur.

The Military Space Forces are concentrating attention on priority work for ensuring guaranteed and independent access of Russia to space: the infrastructure of the First State Test Cosmodrome Plesetsk is being further developed and work also should begin on constructing the Svobodnyy cosmodrome in the Far East.

Implementation of the plans is impossible without smooth operation of the plants constructing rocket-space equipment, their subcontractors and the producers of rocket fuels. But this requires priority funding of space activity.

However, for the time being it is planned that 1.2 trillion rubles will be allocated to the space branch, despite a minimum need for 2.2 trillion rubles.

Russian Space Activity in 1994 Outlined

957A0117D Moscow SEGODNYA in Russian 12 Jan 95 p 9

[Article by Vladimir Sergeyev:" Russian Cosmonautics Has Succeeded in Saving Face. Talk Now is About 1 Percent of the GNP"]

[FBIS Translated Text] The principal "space" achievement of Russia during 1994 without question can be considered to be that it was able to maintain the scope and intensity of space activity, and in some directions also ensure a buildup of potential. During the past year the Military Space Forces (MSF) of Russia, ensuring the practical realization of our interests in space, carried out 49 launches of boosters which put into orbit 64 satellites for different purposes. There were launches and tests of new promising space vehicles for communication and TV broadcasting (Gals, Ekspress), meteorology (Elektro), as well as for scientific (Korona S-I) and military purposes.

It is particularly necessary to note the beginning of on-line use of the GLONASS global navigation satellite system, with a high accuracy making it possible to determine the coordinates of an object at any point on the Earth. Its development occurred on the order of the Ministry of Defense, at the expense of the military budget, as was work on the further improvement and development of this system. During last year the GLONASS system was supplemented by 9 new satellites, and already this year plans call for completing deployment of the network, which will include 24 satellites and will make it possible to ensure continuous global three-coordinate position determinations.

During 1994 the MSF also launched nine communications and TV broadcasting satellites, of which seven were put into geostationary orbits.

During the past year, in order to support work programs on the Mir orbital manned complex, three manned Soyuz TM ships were launched to it, as well as five Progress M cargo transport ships. During the past year a total of 310 billion rubles [R] were spent on implementing the manned program.

Now working in the complex is the 17th main expedition, made up of Aleksandr Viktorenko, Yelena Kondakova and Valeriy Polyakov; the latter has already been in space a record number of days—370 (as of 12 January 1995). The female record for presence in space is held by Yelena Kondakova—101 days.

Satellites Launched by Russia in 1994

Satellite name	Satellite purpose	Cosmodrome of launch		Notes
		Baykonur	Plesetsk	
I. Civilian and "dual" purpose satellites				
Soyuz-TM	for supporting work program of Mir OMC	3	-	manned spaceship
Progress-M	same	5	-	cargo transport ship
Gals	communications and TV	1	-	geostationary
Gorizont	same	1	-	same
Luch	same	1	-	same
Molniya-1T,-3	same	-	2	same
Raduga*	same	3	-	same
Raduga-1	same			same
Ekspress	same	1	-	same
Meteor-3	meteorological	-	1	same
Elektro*	same	1	-	same
Kosmos	navigational	9	-	GLONASS system
Geo-IK	geodetic	-	1!	
Nadezhda	accident search and rescue	-	1	international COSPAS-SARSAT system
Okean-01	oceanographic research	-	1	
Resurs-01	study of Earth's natural resources	1	-	
Korona S-I	scientific	-	1	
Radio-Rosto	radio amateur	1	-	invention of radio by A.S. Popov
Foton	industrial	-	1	
Total		27	8	

Satellites Launched by Russia in 1994 (Continued)

Satellite name	Satellite purpose	Cosmodrome of launch		Notes
		Baykonur	Plesetsk	
II. Military satellites				
Kosmos	for RF Defense Ministry	9	20	
Total		36	28	

*satellites put into orbit for first time

In general, however, launches of craft under the manned program have constituted only 12.5 percent of all the launches of Russian satellites.

During 1994 work was continued on study of the Earth from space using space vehicles. The Geo-IK geodetic and Okean-01 oceanographic satellites were launched from Plesetsk, whereas the Resurs-01 for studying the Earth's natural resources was launched from Baykonur. The Foton industrial satellite (intended for obtaining new materials under weightlessness conditions) and the scientific satellite Korona S-I of the AUOS series (studying the nature of solar-terrestrial relationships) also were launched into space from the northern cosmodrome. Both launches took place with broad international participation. It is gratifying to note that after a year-long interruption in launches of scientific satellites taking place in 1992 due to the financial problems of the Russian Academy of Sciences, the launch of satellites of the AUOS type nevertheless took place.

Together with the Elektro geostationary meteorological satellite, launched for the first time, whose preparation for launch lasted 12 (!) years, the Meteor-3 meteorological satellite, which carried into space the subsatellite Tubsat, becoming the first West German and the 13th foreign satellite launched from our cosmodromes, was launched from Plesetsk. The Nadezhda rescue satellite of the international COSPAS-SARSAT system used for search for and rescue of aircraft and ships which in distress also was launched by the MSF from the northern cosmodrome.

It also is impossible not to mention the launch from Baykonur of the ham radio satellite Radio-Rosto, which was put into orbit by the Rokot light-class booster, undergoing flight tests. This was the first orbital launch of the booster.

During the past year much attention was devoted to the development of the space infrastructure in the territory of Russia. An extremely important element in the independent space policy of Russia is that already for two years now the Military Space Forces have been controlling the entire orbital grouping, in its makeup now including more than 170 space vehicles, solely from Russian territory. Last year work was continued on strengthening the Russian control system, which made it possible to compensate for the loss of facilities in Kazakhstan, Uzbekistan and the Ukraine.

On 11 November 1994 the president of the Russian Federation signed a decree on establishing the Plesetsk cosmodrome, which laid the basis for the further development of this cosmodrome, for the time being the only one in Russian territory. Last year 19 space rockets were launched from there and these put 28 satellites for different purposes into orbit.

A further buildup of efforts for ensuring guaranteed access of Russia to space also involves the implementation of full-scale work on establishing the Svobodnyy cosmodrome in the Far East. This is necessary for the step-by-step transfer of booster launches from Baykonur to Russian territory.

The past year can be called the turning point in the fate of Baykonur: finally it was possible to determine its juridical status with certainty. The functioning of the Baykonur complex is in the hands of Russian troops in the form of the Military Space Forces. Russian laws are in effect there and the head of the administration of Leninsk, the capital of Baykonur, is designated on the nomination of Russia.

During the past year 30 boosters were launched from Baykonur, including 13 launches of the heavy Protons, a record number of launches without accidents since 1984. Thirty-six satellites were put into orbit.

In general, however, the principal load in implementing the program of space launches during the past year, as usual, was borne by the Soyuz and Molniya boosters (almost 37 percent of all launches). Developed on the basis of the legendary "Korolev" No 7, to this day they are the most massive of those used by the Military Space Forces.

Launches of Russian Space Rockets During 1994

Booster name	Booster class	Cosmodrome of launch		Total	Notes
		Baykonur	Plesetsk		
Kosmos-3M	light	-	5	5	
Rokot	same	1	-	1	
Tsiklon-2	same	1	-	1	
Tsiklon-3	same	-	7	7	including one accident, 25 May 94
Zenit-2	medium	4	-	4	
Molniya-M	same	-	3	3	
Soyuz-U,-U2	same	11	4	15	
Proton-K	heavy	13	-	13	
Total:		30	19	49	

Unsolved problems also exerted an appreciable influence on the space activity of Russia during 1994. Most important was funding. Being inadequate and at the same time provided on an irregular basis, it exerted a negative influence on the production of space equipment, the development of its new models, as well as on purchases of boosters and satellites and on capital construction at cosmodromes. The rates of "aging" of the orbital grouping have accelerated: now almost ⅔ of the more than 170 Russian space vehicles in orbit have exceeded their guaranteed useful life. This problem has arisen due to disruption of the plan for deliveries of boosters and space vehicles (state orders for 1994 for deliveries of rocket-space equipment were only 25-percent filled).

If during the new year there is no fundamental reexamination of the approach applied in problems relating to funding of the space branch, already from late February, for example, there realistically may be an end to implementation of the manned flight program and it is not impossible that there will be problems with orbital groupings of unmanned space vehicles, including those for military purposes.

During the past year the RSA [Russian Space Agency] could not organize the launch of even a single satellite of the Resurs-F type for photographing the Earth's surface. The times for launch of the Prognoz-M2 satellite under the international Interbol program fell through. The launch of a space station to Mars also did not take place. Twenty-two countries, which already have expended a total of $300 million, are participating in this project.

As a result of lack of funding the RSA has begun to cut down on rocket use. For example, during work of the 16th main expedition aboard the Mir OMC only one cargo ship was launched to the complex instead of the planned two. The second Progress M, together with the Soyuz-U booster, was not launched for economy purposes. Our civilian cosmonautics today does not have a single spare rocket, not a single spare ship. Only recently the RSA was forced to get four boosters from the military.

Meanwhile, according to expert evaluations, in order to put an end to the further stagnation of the rocket-space branch in 1995, it is necessary to ensure its stable funding in an amount not less than 1 percent of the gross national product, in the RF law "On the Federal Budget for 1995" making provision for the funding of space activity in the country as a separate item.

Information Security in Data Processing Systems and Networks

957G0015A Moscow PROGRAMMIROVANIYE in Russian No 5 Oct-Nov 94 (manuscript received 2 Sep 94) pp 5-16

[Article by Vladimir Konstantinovich Levin; UDC 519.685.3]

[FBIS Translated Text]*As the use of computers evolves, it is becoming urgent to protect programs and data from all kinds of malicious infringements during processing, storage and transmission. This article describes possible dangers of this kind, and security measures that are taken with consideration of a certain gradation of requirements. It is emphasized that these operations have to be combined on all system levels: in hardware and software, in the area of standardization and legislation, and in organizational issues.*

The problem of protecting information, or what amounts to the same thing, information security, secure information systems, is occupying a more and more significant place, both in the implementation of computer systems and networks, and in providing information to society. The danger of malicious distortion, falsification and theft of information, and consequently the need for protection from such action, exists for all forms of information storage, transmission and processing. Measures of this kind of security are associated in part with protection against unintentional interference and errors, with assurance of reliability, fidelity and correctness of system operation, electromagnetic compatibility and requirements of ecology. Operations in the area of providing information will be depreciated and harmful unless proper provisions are made for securing information against leaks, unauthorized access and interfering actions, and therefore security issues have to be considered as part and parcel of all functions of computer systems to ensure their most effective construction and application. Of course, for purposes of structuring the jobs to be handled, the field of security is singled out as a separate area, and this article reviews concepts in this area.

Any security is built around notions of danger of incursion, and with regard to technical and economic comparison of the expenditures and capabilities of either side. There has to be a classification of dangers, standardized models of incursion, and on the other hand, assessment of information by categories of value, sensitivity, by time requirements for safekeeping, and the like.

Legal, administrative, moral and ethical standards of information security are being complied in one form or another, where information is treated as an object of property, commercial and financial relations, rights of authorship, and political relations. Regulations are being established for use and responsibility for actions that cause damage when working with information [1-3].

Legal standards must define categories of open and limited, regulated access to information, rights of establishing authorization and procedures for accessing and monitoring access, responsibility for specific legal violations. Legal support of information security as a whole is lagging behind the needs of the rapidly evolving computerization of all areas of human endeavor; in our nation the matter is further complicated by the difficulties of formation of law and order under conditions of renewal of social and economic relations. One of our acute problems in the information industry is illegal duplication and proliferation of software and data files under conditions where existing security measures are often on a primitive level in both the organizational and technical sense, and legislative- administrative standards are diffuse. It is only for high-level state services that information security is oriented toward dangers involving potentially possible complex and costly methods of incursion. In foreign practice, a certain level of legal and hardware/software support of information security has already evolved, and issues of a higher level are in the stage of discussion and development. For example, a hardware/software system has been set up for handling evidence of unauthorized actions with information that could be used in a court trial for presentation of corresponding claims. It is being ascertained just how legal it might be to remove (disclose, decipher) security measures and reveal the internal workings and content of software and data files, even when allegedly done with the good intention of furthering progress.

We might point out that many provisions of the corresponding legislation of our country are, generally speaking, applicable to information security, but the practice of applying them has not yet evolved. There is a great difference in the approach to issues of this kind in the statewide political, business and private sectors. Despite the importance of forming legislative and administrative standards and their practical introduction, there has to be intensive parallel satisfaction of the vitally important needs of information security by a set of organizational and technical measures in all areas of the information industry. These operations will have to be defined by such attributes as standardization, certification of quality, technical support and maintenance of security measures, instruction of personnel on all levels, licensing of certain forms of work and the like.

In information security operations, a certain state of secrecy is inevitable, since both the attacking and defending sides are trying to gain an advantage from hiding their actions. In this context, there are two viewpoints. One can conceal everything having to do with the area of security (including one's own assessment of the capabilities of the attacking side) with the assumption that this will minimize the chances of the opposing side. In the alternative option, the overall design of protection (structure, concept, and so on) is taken as generally known, and its security is provided by hiding certain parameters (code values of keys, passwords, signal attributes and the like), which on top of all this are

changed in accordance with some schedule. In the first option, which is typical of many conventional communication systems, a large body of general facts about the system and its security must be hidden for a long time; however, this information as a whole is accessible and known to a considerable number of people who have been involved in developing and maintaining this package, making it problematic to guard against information leaks, so that security is safeguarded mainly by keeping keys hidden. Therefore, the second aforementioned option is becoming predominant in modern computer systems in which a large number of people are at work, and on the conceptual level the problem of information security has to be assumed as generally known, and must be designed to be kept secure by hidden keys. An important aspect of openness to some extent in the area of data security is accessibility for assessment and expert evaluation of basic solutions on the level of the highly competent science and engineering community, which is a decidedly significant factor of confidence in the soundness of a security system, as such is generally implied not just by mathematical and engineering concepts, but also by the recognition that many experienced, highly competent and capable people have failed to find ways to break security.

In characterizing the approach to the problem of information security as a whole, we should stress the need for considering the specific circumstances and conditions of formulating a task, guarding against trying to be too versatile and universal in solutions. At the same time, any real security system cannot be reduced to a mathematical idea or special engineering implementation, as it involves a set of measures of different kinds, including scientific-engineering, legal, organizational and economic.

The basic types of information protection are systematized and classified in compliance with the specifics of the objects of security, i.e. computer systems, where in application to security issues a division is made into computer hardware proper, communication channels and switching systems, software on the systems and applied level, and the system-wide organization: the computer network as a whole [1, 3].

The following kinds of activity have now evolved with respect to information security that reflect the nature of information property, practical requirements, and organizational structure:

1. Security against unauthorized access (UAA) in computer system hardware and software.
2. Security of information during transmission through communication channels and in switching facilities.
3. Security of legal integrity of so-called "electronic" documents (in electronic mail systems, and so on).
4. Security against information leaks in the form of spurious electromagnetic emissions and pickups (SEMEP).
5. Security against software viruses.
6. Security against unauthorized duplication and distribution of software and valuable databases.

The security measures that are taken in all the aforementioned subdivisions depend on the degree of sensitivity and other assessments of the significance and value of information. These measures, like methods of incursion, are likewise divided into active and passive, depending on whether the initial information to be protected is transformed (distorted) or left unchanged.

The essence of active and passive measures for different kinds of security will be explained below.

It might have been assumed that of the aforementioned kinds of security, the first applies to computers proper, while the second pertains to communication facilities, the third and sixth focus on certain classes (or areas of application) of computer-aided management and information service systems (CAMS, CAISS), and the fourth and fifth are more or less significant for all tasks of computerization. No comment is made here on specifics of terminology that reflect, among other things, the prerequisites and prehistory of development of different objects and forms of security.

In considering security methods and procedures, we take note of two that to some extent have been present in all security systems since ancient times: organization of physical protection of transmission channels and points where data are located (organizational measures) and information coding (cryptographic methods of protection). The combination of these two classes of methods was the basis of design of secret communication systems of the "precomputer" age. In personal computers, computer systems and networks, the problem of information security becomes, on the one hand, more multifaceted and complex, as various possibilities for accessing and acting on information arise, but at the same time the computer, as a powerful means of transforming information, opens up new possibilities for protection. Thus, organizational measures and cryptography are treated as part of the entire package of security measures.

Cryptographic protection proper involves transforming information by some encryption algorithm, and in that form transmitting or storing it so that it remains inaccessible to those who do not have the code key for decryption (see Appendix). In general form, the encryption algorithm may be open (generally known), but its specific meaning is assigned by a key whose discovery, because of the enormous number of sequential searches and the complexity of the algorithm, is unrealistic from the standpoint of technical-economic expenditures, or even guaranteed to be unrealizable. Various encryption algorithms are used, depending on needs. The one that is recommended for computer systems is the guaranteed secure encryption algorithm in accordance with State Standard GOST 28147-89 that is realized in a number of Russian software/hardware data security packages. Due

to complexity, software implementation of the encryption procedures uses a lot of computer time. Hardware implementation of encryption is done by LSI-based expansion modules installed in the computer; although this costs more than the software version, the difference is compensated by providing high productivity, as well as by more isolation of the encoder from other computer functions to avoid possible mutual interference.

There are two approaches to implementation of cryptosecurity: encryption of data files (precoding) and encryption of information "on the fly" (line encryption): coding in information channels. In the former case, the data file is converted/encrypted, and copied from one area of computer memory to another. In encoded form, this file may be stored for a long time or transmitted over any communication lines without danger of being compromised even in the case of direct outside access to the carrier or data transmission channel; usually in this case the information is stored and transmitted in combination with an open address indicator (like a printed letter with encrypted text and open address printed on the envelope). Line encryption is done by some encoder embedded in a given data channel, the information is encrypted in "transparent" mode, unnoticeable to the source and target of the information (although procedures for setting up communications may be required that do not involve encryption as such; there is also some increased delay of transmitted signals). On the level of computer system users, both of the aforementioned modes of cryptosecurity can be interpreted by each other regardless of the specific physical implementation, and the choice of this implementation is determined by the design of the security system for the CAISS as a whole.

A difficult problem for networks with a large number of subscribers when using data encryption is the distribution and use of keys without risking compromise. For systems that have developed to some degree, this is handled as a multilevel problem, where keys are provided partly with organization of a special safeguard (courier communication and other isolated channels), and partly through special encryption procedures, and in certain sections by open codes that are used for generating subscriber keys by preagreed and rather complicated procedures. However, the difficulties of the problem of keys are still a serious obstacle in the development of branched computer systems with a high level of data security.

The use of cryptographic tools on both the software and hardware level should be accompanied by comprehensive engineering analysis of possibilities of defeating, weakening or falsifying the action of these tools on the part of other sections of the computer and its software, interference, errors or malicious actions of persons having access to the computer where cryptographic tools are being used. Strict measures should also be taken to safeguard encryption keys (which generally speaking are more sensitive from the standpoint of compromising the system than are individually taken blocks of information).

Protecting computer systems from unauthorized access (UAA) is based on designing software and hardware in such a way as to ensure delimited access to data by checking requests of subjects of access (users, processes and the like) and the characteristics of their authorization prior to offering access to objects of information (records, devices, software and the like). These functions must be accomplished in the computer by a certain delimited access supervisor that during implementation of the security algorithm (formal model) must have properties of verifiability (for correspondence to the prescribed model), immunity to accidental or intentional modification, and completeness of monitoring of attempts to access protected objects through all possible channels. Functions of access delimitation are added to operating systems and database management systems, and also partly provided as independent software items [1, 4, 5]. Considering the difficulties of realizing security measures within the scope of traditional operating systems, multilevel delimited-access systems utilize the concept of a firmware security core for verifiably correct realization of access supervisor functions. The primary hardware functions used in the system are those that are conventional in organizing multitasking and multiprocessor operations, and certain additional functions as needed (privileged program control modes, lockout in the interrupt system, security keys for memory segments and virtualization of memory, use of program ROM, hardware implementation of abstract data types, tag architecture and the like). A good idea of structural organization of software for creating secure computer systems is the concept of the "virtual machine." Even from the brief overview given here, one gets a feeling for the difficulties of setting up security by "purely computer" means, and they have to be combined with objectively organized measures, with the use of cryptographic tools, and as a result one often has to come up with specialized computers and software.

In the area of standardizing issues of security against UAA, the United States published a series of documents in 1985-89, the main one being the standard "Criteria of Evaluating Security of Computer Systems" (the so-called "Orange Book"), in accordance with which computer facilities and systems are certified for corresponding requirements. A document along these same lines was endorsed in the European Community in 1991. With allowance for practice here and world-wide, guidelines were developed and approved by the Russian State Committee on Technology in 1992:

- Concept of security of computer hardware and computer-aided systems against UAA.
- Terms and definitions in the field of data security.
- Indices of security of computer hardware.
- Classification of computer-aided systems and requirements of data security.
- Temporary provisions on state licensing of operations in the field of data security.

In connection with the extensive use of foreign computer hardware and software, data security tools are being acquired either bundled with a shipped package, or as far as possible built into acquired hardware and software, or are introduced by a specially created firmware "shell" system that isolates computer facilities from possible sources of unauthorized access. Under these conditions, a high measure of security can be realized with consideration of the particular specialization of systems by combining firmware and organizational steps.

Protection from access to data files and programs for the purpose of unauthorized duplication and subsequent use with violation of property rights is singled out as a separate problem. If encryption of file content in such cases is seen to be inconvenient and expensive, then various kinds of security passwords are used in the system of organizing access, and inserts and tags that are difficult to remove are added to the software to block the use of stolen files for their intended purpose. While "locks" of this kind can be opened and removed, although with difficulty, they nevertheless can be considered acceptable for preventing uncontrolled mass duplication and distribution of data and software.

Protection of information in communication systems (telecommunications) or in territorially distributed computer systems must, first of all, take into consideration that long-distance communication channels pass over unguarded territories or are accessible by radio interception and subject to interruption (or jamming) of various kinds, as well as falsification and diversion of information. Therefore a major role is played here by data encryption and various kinds of concealment, for example to prevent determination of messaging schedules or the topology of message transmission in the network (traffic).

The terminal sets and switching nodes of modern communication systems are designed around extensive use of computer technology, and therefore the overall principles of security of computer systems are applicable in large measure to them as well. At the same time, a rather extensive system of standardization is used in the field of communications that also covers issues of information security. The basic conceptual document is international standard ISO/IEC 7498-2 "Base Reference Model of Open System Interconnections (OSI). Part 2: Architecture of Security," and the analogous CCITT document "Recommendations X.800: Architecture of Security of OSI for Use in CCITT." The term "open system" denotes the possibility of interconnection with other systems meeting the same standards. System functions are distributed in the reference model on seven levels. The architecture of data security is the basis for the corresponding system of standards, and describes possible dangers and a set of functions—security services:

- recognition of recipient and sender,
- access delimitation and monitoring,
- secrecy of calls,
- messages, data fields and traffic,
- monitoring integrity of messages and data with possible recovery,
- authentication of sending and delivery,
- encryption,
- authentication of subscribers and their signatures,
- concealment of traffic,
- and routing control.

The ISO and CCITT standards are advisory and may be introduced by stages in agreement with other standards in the area of communications. However, there are systems and networks now in existence and being introduced that are not in line with the aforementioned standards because of problems in assimilation of standards, or for the purpose of simplifying solutions based on a particular specialization, and sometimes because of conceptual conflicts with the aforementioned seven-level model.

The problem of protecting communication systems as such is integrated with the problem of protecting computers, since such integration is accomplished on the level of user functions and needs and on the level of computer hardware and software and communication channels. Indeed, the problems of computers and communications merge when realizing electronic mail, a computerized banking network, remote interactive shared access to large computing centers, a multifunctional digital telecommunications network, controlling a network of processing facilities, and the like. But here, there are many obstacles that are difficult to overcome, especially when it comes to security issues, and therefore integrated approaches are sometimes replaced with strict delimitation of electronic mail away from interaction with the remote computer, isolating points of encrypted communication, banking services, and so on.

Certification of electronic documents, various kinds of authentication and issuance of receipts are becoming increasingly important as computerization and telecommunications expand. Here there is no need to conceal the contents of the document, the address or signature, but it does have to be confirmed that they belong to a source or person, and this on a level of legal confirmability, security against forgery or diversion to a false address. In general, security measures like those mentioned above are used. They are rather fully described in ISO standards, but in addition attention must be given to the specifics of conditions, requirements and recommendations, as striving for universality may overload security and make it ineffective.

Leakage of information due to SEMEP may take place through the following channels:

- informative electromagnetic emission from different parts of a computer that might be caught by methods of radio interception beyond the limits of the safeguarded zone;
- accidental reception antennas in the form of conductors of electrical equipment (telephones, electric watches, and the like) that may be near a computer and have circuits extending beyond the confines of the safeguarded zone;

- wires and cables that are electrically connected to the computer and go beyond the confines of the safeguarded zone (including cable shielding, grounding wires and the like on which informative signals may be picked up through parasitic coupling);
- power supply grid in which changes of current consumption can be detected that are associated with information being processed, primarily in low-frequency and electromechanical devices.

Signals in a wide frequency band from the lowest frequencies to the level of GHz may be dangerous. The greatest sources of emission (and re-radiation of induced signals) are the video section of monitors, inadequately shielded cables, the keyboard and printer.

Protective measures that are used are metal shielding cases and current-conducting covering of plastic casings, current-conducting transparent coatings of display screens (based on special materials, metallizing, fine-mesh conductive grid), double shielding of interfacing cables, filters and decoupling on outgoing cables and supply circuits. Of course, it would be desirable to introduce these measures into the design of computers during planning and industrial production, but often, especially in the case of import, purchased computers have to be upgraded to allow for security requirements.

Requirements of protection against leakage of information by SEMEP are spelled out by standards of the Russian State Committee on Technology, and are modified with allowance for sensitivity of the information to be processed and the size of the safeguard zone. To a certain extent, these requirements overlap with those of electromagnetic compatibility (i.e. limiting interference from a computer for nearby electronic equipment, and protecting the computer from external interfering radiations) and ecological standards (since emissions of the computer, and especially of the display, may be injurious to people).

In addition to protective measures in the computer proper, steps of a material nature are needed that relate to placement of surrounding equipment, good grounding, and decoupling of supply circuits (right up to the installation of intermediate generators or self-contained sources). In the most crucial cases, overall shielding is provided for the room of the computer center.

In some cases, the aforementioned security measures cannot be carried out, or they are insufficient, and then active security measures are used in the form of noise signal generators (in the range recognized as dangerous from the standpoint of information leakage). "Selective" and concealing interference may also be generated to protect specific devices and signal transmission lines of a computer complex. However, active security measures reveal the location of the object and complicate satisfaction of requirements of electromagnetic compatibility with other equipment.

Trends of miniaturization and reduced power consumption of electronic equipment are reducing SEMEP, and consequently simplifying protection. In complex high-productivity computers, the compact placement of dissimilar equipment and parallel signal codes result in mutual masking of SEMEP that makes it difficult to extract information, and therefore security measures are localized mainly on input/output devices.

The class of questions being considered here also includes detection and protection against "bugging," i.e. various kinds of active hardware put into the computer that can relay information to the outside or create interference and sabotage the computer. When it is impossible to disassemble the computer to make an adequately through check for bugging, complete shielding of the working room may be needed, as ordinary measures of protection against SEMEP are not designed to eliminate the operation of bugs. There is a danger of hardware bugging in cases where there is no confidence in the loyalty of the manufacturer/dealer, transportation and storage of computers are not monitored, and when the point of destination (service) of the shipped computer is known beforehand; general shipments are not likely to be bugged.

Maliciously bugged programs,"viruses," "Trojan horses" and the like are increasingly becoming a headache as computer systems and networks develop in consequence of the diversity and uncontrollability of software shipments and difficulties of protecting complex software systems from diversions of this kind.

At the present time, most computer users have provided themselves with various means of checking newly acquired programs and data for "infection" with viruses; however, facilities of this kind are not universal, as it is difficult to foresee the harmful properties of newly invented bugs.

In the worst cases, it may be necessary to wipe the memory clean, which means losing information, or expenditure of considerable time on recovery, and therefore it is increasingly being recognized that software and databases have to be so designed as to minimize their susceptibility to attack by software bugs, and in addition special hardware means of security may be introduced.

Conclusion

The need for data security is being increasingly perceived in all areas of the information industry, and is a significant factor in the design and operation of computer systems and networks. In this area, legal norms are being developed in parallel with hardware and software security measures and corresponding standards, organizational measures are being arranged with licensing of certain operations and certification of goods. Until recently, data security operations were the realm of a narrow class of state services, the centralized administration of economy, and military organizations; however, they now play a significant part in the financial, business and private sectors, in organization of industrial production, and essentially in all needs of information service wherever there may be considerable competitive interests.

Many users require personal keys and passwords for security of their own data, safeguarding against accessibility from the outside, and therefore it is impossible to limit implementation of security only to internal hardware and software checked by the manufacturer and service provider isolated from the user; the issue of faith and trust of the user is extremely urgent. This article has not looked into questions of quantitative estimates in the field of data security. Of course, quantitative estimates are present for all phases and segments of protection: standards, models, parametrization of initial requirements and conditions of performance, and criteria for evaluating results. However, such estimates are generally intangible for the user, as he only needs confidence in the adequacy of protection within the scope of a general evaluation of expenditures for a system, and quantitative estimates are merely the realm of professionals in this business. In the environment of the scientific and engineering community associated with the use of computers, a certain level of understanding of data security problems has to be formed that is based on proportionality of dangers and expenditures for security, the combination of organizational measures, hardware and software, and accounting for administrative and legal standards on all stages of work: design, development, service and maintenance of computer systems. Mutual relations have to be arranged between the user environment and professional organizations engaged in data security, and issues of public and state control have to be regulated.

There has been noteworthy expansion and systematization of information on scientific-engineering and organizational problems of data security with consideration of both domestic and foreign efforts in this field [1, 6, 7].

References

1. Levin, V. K., Gaykovich, V. Yu., Doroshkevich, P. V., Sokolov, Yu. V., Timofeyev, Yu. A. et al., "Data Security of Computer Networks" in: "Tekhnologiya elektronnykh kommunikatsiy" [Technology of Electronic Communications], 1993, Vol 45, 128 pp.
2. Brusnitsyn, N. A., "Structure of Legislative Support in the Area of Data Security," ZASHCHITA INFORMATSII, No 1, 1992, pp 21- 34.
3. "Kontsepsiya razvitiya bezopasnykh informatsionnykh tekhnologiy. Obespecheniye zashchity informatsii v proyektakh informatizatsii Rossii" [The Concept of Expansion of Secure Information Technologies. Safeguarding Data in Projects of Expanding the Information Industry of Russia], Moscow, 1992, Ministry of Science, Republic Scientific and Engineering Council on Expanding the Information Industry in Russia, Kvant Scientific Research Institute, 149 pp.
4. Spesivtsev, A. V., Vegner, V. A., Krutyakov, A. Yu., Seregin, V. V., Sidorov, V. A., "Zashchita informatsiiv personalnykh EVM" [Data Security in Personal Computers], Moscow, Radio i svyaz, 1992, 190 pp.
5. Grover, D., Sutter, R., Phipps, J. et al., "Software Protection," Moscow, Mir, 1992, 285 pp.
6. Maftic, S., "Security Mechanisms in Computer Networks," Moscow, Mir, 1993, 216 pp.
7. "Advances in Cryptology," Eurocrypt '93 Proceedings, October, 1993, in: "Lecture Notes in Computer Science," 1994, Vol 765, 467 pp.
8. Vinogradov, I. M., "Osnovy teorii chisel" [Principles of Number Theory], Moscow, Nauka, 1981, 176 pp.
9. Diffie, W., "The First Ten Years of Public-Key Cryptography," TRUDY INSTITUTA INZHENEROV PO ELEKTROTEKHNIKE I RADIOTEKHNIKE, Vol 5, No 4, pp 54-74 (and other articles in this issue).
10. Lebedev, A. N., "Public-Key Cryptography and Possibilities of Its Practical Application," ZASHCHITA INFORMATSII, No 2, 1992, pp 129-147.

Vladimir Konstantinovich Levin graduated from Moscow Power Engineering Institute in 1950. Doctor of Technical Sciences (1974), Professor, Associate Member of the Russian Academy of Sciences (1987). Presently director of Kvant Scientific Research Institute. Scientific interests—computer technology.

Conventional Encryption and Public-Key Systems

In encryption that is done either manually or by means of hardware (electromechanical and electronic encoders and computers that contain encryption programs or hardware modules), the initial information I (plaintext) in the form of an alphanumeric sequence, binary telegraph code, and so on is transformed with the use of encoding key K_1 by some function F_1 (encryption algorithm) to encrypted text T:

$$T = F_1(I, K_1).$$

Decryption is done by using the corresponding decoding key K_2 and algorithm F_2:

$$I = F_2(T, K_2).$$

"Conventional" ciphers are constructed so that $K_1 = K_2 = K$, and transformation F_2 is reverse (or identical) to F_2, as if a lock were opened and closed with the same key turned to the left or to the right. Transformations F_1, F_2 may be generally known, and the concealment of the cipher may be ensured by the fact that the key K is known only to the participants (subscribers) in information exchange. The security of the cipher is determined by the combination of complexity of F_1, F_2 and multiple options of K. The classical unbreakable cipher uses a key K made up of random equiprobable alphanumeric sequences of the same length as the transmitted plaintext I; encryption is done by addition modulo A:

$$T \equiv I \oplus K (\mathrm{mod}\, A),\ I \equiv T \oplus K (\mathrm{mod}\, A),$$

where A is the number of symbols in the used alphabet.

Key K in this cipher must be used only once; reuse will enable breaking the cipher. Therefore, the volume of key information that is needed is equal to the volume of information I being transmitted, and despite the simplicity and security of the cipher, it is applicable only to bilateral low- intensity data exchange.

In reality, rather complicated encryption transformations F_1, F_2 are used that ensure high security with relatively small volumes of key information K. Among just such encryption algorithms is that recommended by State Standard GOST 28147-89. In addition to the level of security as a basic problem of the cipher, it is very important to solve an entire complex of related engineering and organizational problems such as reliability of equipment operation, safeguarding concealment of keys, acceptable pricing, and so on.

In the last 15 years, several varieties of so-called "public-key" ciphers have appeared. Here the encoding and decoding keys K_1 and K_2 are different, and such that knowledge of one of them for practical purposes does not enable determination of the other, and therefore one is declared publicly accessible. In the RSA system that is typical of this type (the name comes from the initial letters of the authors' surnames [Rivest-Shamir-Adelman]), the information I to be encoded is treated as an integer $I < M$, where $M = BC$, B and C being sufficiently large different prime numbers.

The product $E = (B - 1)(C - 1)$, which is called Euler's function, is used to form keys K_1 and K_2: one is an arbitrary integer, and the other is chosen from the condition $K_1 \times K_2 \equiv 1 (\mathrm{mod}\ E)$. Encryption is done by the formula

$$T \equiv I^{K_1} (\mathrm{mod}\ M).$$

With consideration of the properties of Euler's function (see [8], p 47), decryption is done analogously:

$$I \equiv T^{K_2} (\mathrm{mod}\ M).$$

When transmitting secret information, K_1 and M are made **public**, and the recipient, who has his own **secret** key K_2, can use them for decoding. On the other hand, if the task is to **authenticate a signature,** the signatory uses his own **secret key** to encode the signature as the initial information I_s:

$$T_s \equiv I_s^{K_2} (\mathrm{mod}\ M),$$

and public-key decryption enables the recipient to verify the signature:

$$I_s \equiv T^{K_1} (\mathrm{mod}\ M).$$

The initial euphoria regarding the merits of public-key encryption for network structures quickly gave way to recognition of the difficulties involved in analyzing the security of this cipher and the dangers of forgeries (imitosecurity), as well as the enormous amount of computation involved in encryption: exponentiation of multidigit numbers. The security of the cipher is determined by the fact that the values of B, C and E are "deleted" after formation of keys, and it is impossible for practical purposes to determine K_2 from known K_1 and M. It is assumed that guaranteed security in the RSA algorithm requires 512-bit values of M, and possibly even 1024-bit numbers. Other public-key systems for encryption and signature authentication have also been published [6, 7, 9].

There is an opinion that public-key systems are feasible for use in confirming e-mail signatures, and also for distributing key information in cryptocommunication networks, as in these cases the information volumes are small, and therefore high productivity is not required of the encoding algorithm. However, detailed consideration of procedures for authenticating signatures or distributing key information have not yet led to any unambiguous conclusions in favor of public-key systems over conventional encryption [1, 6, 10].

It should additionally be stressed that the use of cryptographic methods must be considered in concert with system-wide organization of data processing and specific decisions on hardware and software. It is rather difficult to build cryptographic tools into already existing computers and communication facilities, as mismatch may show up between interfaces, procedures of interaction, setting up communications, and so on. Moreover, because of the lack of complete documentation on the inner workings of hardware and software being used, it is rather difficult to analyze the danger of any kind of distortions, circumventions and weakening of the action of cryptographic protection introduced into an already existing computer environment. Cryptographic protection might be ill-suited to such software packages as database management systems, since frequent operations with the stored information may be required (associative search, modification, and so on), and this would require frequent recoding, which is excessively burdensome. Under these conditions, security has to be restricted to simple hardware locks and software passwords, as well as rigorous prohibitive organizational measures unless there is an appropriate way to design an entire data security package.

Employment of Multiprocessor Computers for Neutron-Physical Computations of a Reactor

957A0222A Moscow ATOMNAYA ENERGIYA in Russian No 77 Oct 94 pp 257-261

[Article by S.S. GORODKOV, IYaR RNTs Kurchatov Institute; UDC 621.039.51]

[FBIS Translated Text] The principal physical cause of the accident at the Chernobyl nuclear power station (NPS) was, as is well known, an erroneous notion about the properties of high power pressure-tube reactors

(HPPTR), based on simplified computations [1]. While giving credit to the professional quality of people, who performed the computations, we must admit a significant complexity of the problem of computing the physics of this reactor. Thus, the three-dimensional two-group cell-by-cell grid design with 16 layers in height of only one time step (by implicit scheme) without thermohydraulics and computations of complex relationships of cell characteristic as a function of the zone parameters requires about 250 million operations with a floating point. In addition, the capacity of the most powerful computer at that time, the BESN-6 of the Kurchatov Institute of Nuclear Energy (IAE) was about 0.3 million operations with a floating point per second (MFLOPS), and there were only three such machines available per several thousand workers, while, abroad the years before the accident and after the accident were marked by remarkable achievements in computer capacity. It is true that to a great extent these successes were achieved by specific means. Thus, the initial supercomputers, in essence employed so called conveyer processing, which allowed specially prepared vectorized programs to compute many times faster. Unfortunately, not every algorithm can be vectorized. A successful vectorization of a program requires a high degree of workmanship. Because of several reasons, including these, computers with vector processors gained no popularity in our country, and the HEM-3 [2,3] program, apparently remained a single highly vectorized reactor program. Nowadays, the key word for the supercomputer developers and users is parallel processing, which is carried out with multiprocessor computers. A successful conversion of regular, "consecutive" programs for such computers is also complex. This will be the topic of our discussion in this article.

To begin with, let us define more clearly, what MFLOPS is. For some time this figure was a most important computer characteristic listed in the supercomputer advertising booklets. Unfortunately, it turns out that the computer capacity for practical computations is much lower than the advertised. Illustrative but not the worst example is the BESM-6, which is claimed to be capable of performing 1 mil operations per second. In general, the speed of executing different programs, i.e. different sets of operations, when converting from one computer to an other, changes in a variety of ways. Since the consecutive operations within long cycles are mainly used with the HEM-3, we arbitrarily assumed, that with execution of a consecutive cycle

DO1I = 1,5000 1 A(I) = B(I) * C + D(I) 10,000 operations are performed with a floating point. In this paper we will talk about these types of operations, familiar to any user, while the advertising information is probably based on the speed of adding two numbers from fixed cells of cash-memory or on something even more abstract. The capacity of some computers, estimated with a simple test, and time needed for a neutron-physical computation of the HPPTR during a single time-step, is as follow:

Capacity, MFLOPS HPPTR comput.,s. BESM-6 0.3

830 CYBER-936 (without optimization) 1.5

160 CYBER-936 (with optimization) 3.4

74 IBM-PC/XT 286/287 0.034

7300 IBM-PC 3866/387, 30 MHz 0.24

1040 IBM-PC 386/Weitek 0.56

450 IBM-PC 486/487, 66 MHz 1.68

150 Spark-10 RISC 3.56 70

In addition to various P-computers, two base computers are included here. The B-computer -6 was included here to indicate the scale of changes in the computing capacities, the CYBER-936 - as the most powerful one presently available in some domestic institutes which perform the reactor design. The simple test that we proposed can be well optimized with compilations on this computer, as well as the HEM-3 program. The most powerful of the tested computers turned out to be the working station Spark a computer still rarely seen by us. But even with this machine the HPPTR computations require considerable time. This data indirectly supports the fact, that there was no rapid increase in the power of a single processor, and that the computing capacity developed mainly because of greater availability of such processors. Today, when the number of processors is comparable with the number of workers, this trend has reached a certain limit, and if not altogether stops, will at least significantly slow down. Only a simultaneous parallel employment of many processors for a single job can change this tendency. Most, if not all natural processes are parallel. However, they were modeled mostly by the consecutive algorithms. This fact is explained not so much by the nature of human thinking as by the single-processor capacity of computers available at the time when the pertinent algorithms were being developed. Let us also point out, that for a long time the multiprocessor computers remained in a development stage, i.e. were hard to obtain, belonged to various types, produced in a small quantity or were custom made. They were also supported by inefficient software with a narrow specialization and had vague prospects for future implementation. All this did not encourage development of new parallel algorithms and multisequencing of the old ones. especially since the growing computer demands were satisfied by the availability of the single processor computers. Now the situation has significantly changed. New problems ripened, requiring a considerably greater volume of computations. At the same time different companies manufactured identical type elements, which could be used for assembling computer systems with a number of processors ranging from several to tens of thousands. A standard Fortran language with small modifications, needed for organizing the processor's interaction, can be used for programming. New types of computers are now available to the domestic programmers, primarily the ones which employ transputers as

base elements. The transputer is a specialized processor with its own memory starting with one Mbyte, not only capable of a fast execution of arithmetic operations, but of adequately fast transmission of data by its four communication channels-links as well. Several transputers can be mounted on a single board of a P-computer, and several such boards of identical volume will have a computer capacity which not long ago was available only to the supercomputers. The links of different transputers can be connected, to form the required configuration. In order to achieve this, appropriate information must be assigned to the program cofigurator, which will specify the character of linkages between them for the time needed to execute the problem. With parallel processing of any program using several transputers, a particular segment is inserted in each of them. This segment can be executed in parallel with other segments. A specialized operation system simultaneously triggers them at the initial moment, and each transputer executes his segment independently from the other, until it encounters a transmission (reception) operator of some information along one of the links. Here, the transputer waits until the other transputer, connected to this link, is ready to receive (transmit) this information. This is how the operation synchronization is achieved for all transputers. The major task of the programmer with parallel processing is to organize the information exchange between the transputers. Let us illustrate the problem with an example of the HEM-3 program for computing the neutron field in large power reactors. Apparently, no objections could be made to the assertion that the most simple, and probably the most efficient method for parallel processing of the logarithm is the one which is derived in a natural way from its structure. The three-dimensional algorithm of the HEM-3 program was derived earlier by development of the two-dimensional algorithm. Therefore, a uniform computation is performed along horizontal layers of the three-dimensional array, which determined the reason for using a separate processor for each layer, while the program's architecture is retained. This approach is attractive not only because of economy in the volume of the text, which is subject to revision, but because the vectorization of the program is retained. The point is that in the HEM-3, computations within one layer are designed in a form of simple unconditional cycles along all nodes, which allows to accelerate computations by a factor of 5-7 with the use of a vector processor. This is an advantage that should not be lost. The other argument in favor of multisequenced computations using the layer - processor approach is the small number of processors in our computer, which is near to the normal number of layers in three-dimensional computations of large reactors. Because the layers explicitly interact only with the nearest neighbors in the array algorithms, and are processed by identical rules, the corresponding processors must be connected in sequence and contain an identical set of programs. Apparently, the parallel processing is more efficient, when fewer computations in the initial algorithm are executed outside the cycles by layers. In fact, from now on each such cycle will indicate a simultaneous operation of a group of processors, and the more they are loaded, the sooner the count will end. It is also clear that a preliminary minimization of the type of such cycles will reduce the work of multisequencing. In the array program of cycles by layers, first the signal is sent by layers of the external parameters and data is prepared for computations, followed by the iteration process of the solution with a transfer of the results of each iteration to the neighboring layers, followed by the final processing of the results. Thus, at least three different processes are involved; actually there are more. In order to reflect this fact, the cycles by layers, after minimizing their number, were replaced in the initial text by calling subprogram SBHOST (Nproc), where Nproc is the process number. In the sequential algorithm its sole purpose is to call a different subprogram SBROOT (Nproc), which in the cycle by layers will execute the indicated process.

In the parallel algorithm the SBHOST program must provide for a simultaneous operation of a group of processors, after furnishing them in sequence with the process number, which must be executed at this moment, and supplying them with the required information. Having received the pertinent information, the SBROOT program-analog, which is incorporated in each of these processors, must transfer it to the next processor, to execute the required computations and to exchange the results with its neighbors. The described changes were, of course, not the only one. All needed subprograms must have been prepared for simultaneous independent computations at different layers. In order to avoid unnecessary expenditures and to operate within 1 Mbyte limits, it was required to change the method of locating the information in their common memory region. Finally, instead of a single set of subprograms, four analogous were prepared, which allowed to simulate a four-processor computation with a regular sequential computer and to eliminate a large number of unavoidable errors.

As a result, all differences between the sequential and parallel versions of the HEM-3 turned out to be concentrated in two subprograms, with a total volume in the first case being 50 lines, and in the second, applicable to transputers, of about 400 lines, which comprises about 5% of the entire text.

The computations were performed at the Russian Academy of Sciences Scientific Center of Neurocomputers, using a computer which incorporated 5 transputers T800. The advertised capacity of each of them is 1.5 MFLOPS. However, the described test yielded 0.32 MFLOPS, which is comparable to the capacity of the P-computer with a 386/387 processor. The rate of information exchange between the transputers is estimated at 1.2 Mbyte per second.

With a perfect multisequencing by layers, the computation rate would not depend on the number of layers. In our case the version with 16 layers was executed by 18%

slower than with two layers. This is explained primarily by the fact, that with the multilayer computation, unlike with the two-layer, the results of iteration must be provided not to one, but to two neighbors, and in addition, it is much farther to deliver the initial information, along the chain of processors and to collect the final results. The described computation of the HPPTR required 63 sec., which is equivalent to the capacity of 3.95 MFLOPS - the largest of all computers listed here. At the present time, the T800, as well as the 386/387 processor, is quite obsolete. The T9000, a contemporary of the RISC, the advertised power is 25 MFLOPS. If its actual capacity, as in the case of T800, is smaller by the factor of 5, then the HPPTR computations with 16 T9000 will take 4 seconds. With this speed it is possible to model moderately fast HPPTR processes in real time, and to study hypotetical emergency situations of the space burning process, or different transient processes in much greater detail.

Great efforts on increasing nuclear power safety are now aimed at studies of serious accidents. By no means denying its usefulness, we would like to state our conviction, that the main direction for increasing the safety of nuclear power stations must be a much more reliable prediction of their operation in all expected modes. Here, it may be appropriate to point out, that at the Chernobyl NPS the accident did not occur because of the development of unknown natural phenomena. Employing large programmable systems for modeling familiar physical phenomena, if such systems were available and could operate sufficiently fast for a comprehensive analysis of alternative situations, its possible occurrence would have been detected.

High quality predictions can only be made by employing complex modeling systems, capable of executing a huge volume of computations in a real time, or even accelerated time mode. These tasks can not be solved without extensive employment of parallel computations. We have demonstrated the reality of such computations based on the array problem, which in principle, could be multisequenced along the reactor cells, if several thousand processors were available, or along the array nodal points if tens of thousands of processors were at hand. Complex programs for computing cell characteristics at the array nodes can be placed without difficulty there or in the neighboring processors. It is still not obvious, how difficult multisequencing of thermohydraulic programs will turn out to be, but there are no reason to question the theoretical solution of this problem. The main obstacles in the way of developing a modelling system most probably will have an organizational and financial character.

The author is sincerely grateful to the personnel of the Russian Academy of Sciences Scientific Center of Neurocomputers and to its director A. I. Galushkin for kind assistance in carrying out this work.

Bibliography

1. About reasons and circumstances of the accident in the 4th unit of the Chernobyl ANS at 26 April 1986. Report of the USSR Gospromnadzor Committee, 1991.
2. Gorodkov,S.S. Accuracy of some array algorithms in computing space kinetics of power reactors. Atomnaya Energiya, 1993, v. 55, pp 414-444.
3. Gorodkov, S.S. Application of vector processor for reactor computations. ibid 1986, v. 61, No 4, pp 284-285.

Use of Synchronized Chaos Oscillators for Transmitting Information Signal

957A0221A St. Petersburg PISMA V ZHURNAL TEKHNICHESKOY FIZIKI in Russian No 20 12 Sep 94 (manuscript received 9 May 94) pp 65-69

[Article by A.K. Kozlov]

[FBIS Abstract] The literature on the capacity for nonlinear determinate systems to generate chaotic oscillations is reviewed because it is pertinent in work being vigorously pursued in the radio physics field on the synchronous processing of complex signals. The theoretical basis for this research is the possibility for synchronization of chaotic oscillations in dissipative systems, for which several methods are possible. One of the promising applications of synchronous processing of complex signals is data protection during communication. Using a carrier signal a more effective concealment of information is possible as a result of chaos modulation. A study was made of synchronization of two determinate chaos oscillators with unidirectional connection for the fast and slow components of oscillations and on this basis a method is proposed for the concealed transmission of an information signal in such a system. The results of numerical modeling of the processes of synchronization and transformation of oscillations are given. The source of chaotic oscillations used is a radio range tunnel diode oscillator. Induced synchronization is discussed and the method for discriminating an information signal from chaos is outlined. Oscillograms and their corresponding power spectra are shown to illustrate the effectiveness of information signal concealment and the possibility of its discrimination from chaos. The factors governing the accuracy of information signal reproduction are discussed. The described method differs from those described earlier and broadens the possibilities for nonlinear processing of determinate signals. Figures 2; references 10: 6 Russian, 2 Western.

Volume Interaction During the Diffusion Welding of Boron Carbide With Titanium

957A0139A Kiev AVTOMATICHESKAYA SVARKA in Russian No 1 Jan 1995 pp 27-29

[Article by V.N. Zamkov and L.S. Kireyev, doctors of the technical sciences, and M. M. Struina, engineer; Institute of Electric Welding imeni Ye. O. Paton of the Ukrainian National Academy of Sciences; submitted 21 Jun 93 and in final form 25 Oct 93; UDC [621.791.4:539.378.3]:621.315.612+669.295]]

[FBIS Abstract] Volume interaction in the weld zone during the diffusion welding of boron carbide (B_4C + 10% TiV_2) to VT23 titanium alloy was studied. Specimens were welded with an intermediate layer of aluminum 0.5 mm thick on a U-874 machine at temperatures of 560 to 620°C, pressures of 5 to 30 MPa, and weld times of 10 to 180 minutes. Examination of weld microstructure by scanning electron microscopy and x-ray spectrometry showed that, when welding lasted for at least 30 minutes, there were no voids, pores, or other defects in the seams. The interface between the aluminum and titanium alloy was a virtually even line with a clearly defined transition layer, the thickness of which increased as welding time increased. The aluminum-ceramic interface, however, was uneven, with plastic deformation causing the soft aluminum insert interlayer to conform to the shape of the ceramic piece. Evidently, the processes of volume interaction between the ceramic and aluminum are localized at the interface. Physical contact between the ceramic part and the aluminum destroys the structure of those places of the ceramic in contact with the aluminum and, for reasons yet unclear, draws TiV_2 binder to the contact surface. Interaction between the ceramic and the aluminum is a process of mutual diffusion between the metal and the ceramic components. The zone of volume interaction at the ceramic/aluminum interface varies according to the chemical composition of the structural element of the ceramic in contact with the aluminum and has a maximum depth of 10 μm, which was determined by layer-by-layer x-ray fluorescence analysis. Figures 5; references 3: Russian.

Active Thermal Inspection of Moisture Content of Porous Materials

957F0048A Yekaterinburg DEFEKTOSKOPIYA in Russian No 5 May 94 (manuscript received 16 Oct 93) pp 80-88

[Article by V.P. Vavilov, P. Bizon, K. Kressan, E. Grintsato, A. I. Ivanov, O. Kovaleva, S. Marinetti and O.I. Nedavniy, Scientific Research Institute of Internal Flaw Detection, Tomsk; UDC 620.179.13]

[FBIS Translated Text] *The authors analyze measurement of the thermal inertia of wet porous materials by the method of active thermal inspection. Different solutions of the problem of thermal conductivity are considered, and assumptions made to simplify data acquisition are discussed. An error analysis is given that enables optimization of the selected testing method.*

Thermographic measurement of moisture content is an indirect method that relies on high specific heat and the thermal conductivity of water that is detected in time-dependent thermal inspection. This effect is well known in IR surveillance, where daytime-nighttime temperature inversion due to the periodic change of solar irradiation enables both open bodies of water and wet ground to be distinguished. The same method is used to measure the thermal inertia of soil [1] and to detect mines [2]. The different thermal inertia of dry and wet sections has been used to determine the amount of water in frescoes [3, 4], construction materials, and the heat shielding of spacecraft [5].

This paper attempts to present a simple yet physically rather exact analysis of the temperature effects encountered in dry (or "defect-free," to use the terminology of nondestructive inspection) and wet (or "flawed") sections of materials. We will look at the example of measuring moisture content in brick as the basic material for restoration work being done in Italy by the Institute of Refrigeration Equipment (Padua) in cooperation with the Scientific Research Institute of Internal Flaw Detection (Tomsk).

1. Subjects of Inspection. Moisture Content and Thermal Properties

Porous materials such as earth, stone, concrete, brick and the like are treated as a granulated (dispersed) medium that consists of solid, liquid and gaseous phases. The thermal properties of such materials depend on the ratio of these phases, the size of solid particles, and the type of bond between solid and liquid phases [6, 7]. Clearly, materials with different thermal properties may be characterized by a time-dependent temperature field during heating and cooling. In such an approach, complex microscopic effects may be replaced by simpler models that are described by equations of thermal conductivity.

The basic thermal properties of materials

The basic thermal properties of materials are density ρ, specific heat C and thermal conductivity K. Also figuring in the basic equation of thermal conductivity is $a = K/C\rho$. Frequent use is made of the concept of thermal inertia $e = (KC\rho)^{1/2}$, which is especially useful in analyzing unilateral thermal inspection.

The influence of internal moisture content on thermal properties can be more or less easily studied if the values of C and ρ are determined. Clearly water, with its high specific heat [C_w = 4181 J/(kg x K)] and relatively high density (ρ_w = 1000 kg/m^3), when it fills the pores inside a material makes the material heavier and gives it greater inertia when the ambient temperature changes. Moisture content is determined relative to a dry specimen: $W = M_w/M_d$, where M_w, M_d are respectively the mass of water and of the dry specimen. It is physically obvious that:

$$M(W) = M_d + M_w;$$

$$C(W)M(W) = C_dM_d + C_wM_w,$$

where $CW(W)$, $M(W)$ pertain to the wet material (the subscript "d" for dry material will be omitted below). Finally:

$$\rho(W) = \rho(1 + W);$$

$$C(W) = C/(1 + W) + C_w/(1 + 1/W).$$

The water contained in pores not only improves thermal contact between particles, but also displaces air in the pore space. For materials with high porosity, thermal conductivity will increase. Consequently, thermal inertia increases significantly even with relatively small water content, making this parameter informative.

The dependence of thermal diffusivity on moisture content is more complicated.

At first, thermal diffusivity will increase with increasing water content to a maximum, and then will decrease (see data for soil in [6]). The reason is that thermal conductivity initially increases faster than density and specific heat at a low level of moisture content. After the thermal conductivity of the material has come close to that of water, the relative influence of increasing specific heat becomes predominant, and thermal diffusivity decreases.

Nevertheless, the behavior of the aforementioned thermophysical characteristics (TPC) in other wet materials (stone, brick) should be anaylzed individually.

2. Mathematical Model

2.1. Basic formulas and simplified models

The solutions of various one-dimensional problems of thermal conductivity can be found in classical monographs [8-10].

The physically most correct solutions of heating of a plate must include heat exchange on both surfaces. However, with a small increase in temperature of the rear surface, it can be considered adiabatic. Solution of the problem of stepwise heating in this case takes the form

$$\frac{T}{Q/\alpha} = 1 - \sum_{n=1}^{\infty} \frac{2 \sin \mu_n \cos [\mu_n (1 - Z)]}{\mu_n + \sin \mu_n \cos \mu_n} \exp(-\mu_n^2 \mathrm{Fo}),$$

where μ_n is the positive root of equation μtq gm = Bi; Bi = $\alpha L/K$; Fo = $a\tau/L^2$; $Z = z/L$, τ is time.

For thermally thick plates, we can use the solution for a semibounded body:

$$\frac{T}{Q/h} = \mathrm{erfc}\left[\frac{1}{2\sqrt{\mathrm{Fo}_z}}\right] - \exp(\mathrm{Bi}_z + \mathrm{Bi}_z^2 \mathrm{Fo}_z)\,\mathrm{erfc}\left[\frac{1}{2\sqrt{\mathrm{Fo}_z}} + \mathrm{Bi}_z\sqrt{\mathrm{Fo}_z}\right]; \quad (4a)$$

$$\mathrm{Bi}_z = \alpha z/K; \ \mathrm{Fo}_z = a\tau/z^2; \ \alpha \neq 0;$$

$$\frac{T}{Qz/K} = 2\sqrt{\frac{\mathrm{Fo}_z}{\pi}}\exp\left[-\frac{1}{4}\mathrm{Fo}_z\right] - \mathrm{erfc}\left[\frac{2}{2\sqrt{\mathrm{Fo}_z}}\right]; \ \alpha = 0.$$

Fig. 1 shows the boundary conditions in problems of heating of a plate and semibounded body.

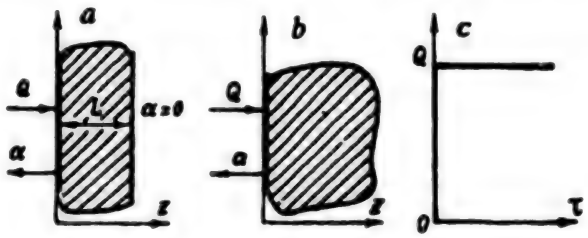


Fig. 1.

Plate of thickness L, heat pulse on one side Q, convection on heated surface, adiabatic conditions on rear side (a); semibounded body, heat pulse Q and convection on surface (b); stepwise heating for plate and semibounded body (c)

Solutions for a plate and semibounded body are compared on Fig. 2. The curve of temperature change in time for the surface of a nonadiabatic plate is shown on Fig. 2a (T is excess temperature; Q is absorbed energy). The thermal properties of the selected porous material (dry brick) are measured independently: thermal conductivity K = 0.54 W/(m x K); density ρ = 1510 kg/m^3, specific heat C = 810 J/(kg x K); thermal diffusivity a = 4.4 x 10^{-7} m^2/s, thermal inertia e = 812.7 (W x s$^{1/2}$)/(m^2 x K).

The coefficient of convection is α = 4.3 W/(m^2 x K). In equation (3), the first four terms of the series were considered with corresponding values of the Biot number Bi = 0, 2; roots of transcendental equation [10]: μ_1 = 0.4328, μ_2 = 3.2039, μ_3 = 6.3148, μ_4 = 9.4459. The same solution is shown on Fig. 2b as a function of $\tau^{1/2}$ to verify the departure from linear dependence that is well known for a semibounded body. If a plate is replaced by a semibounded body (see (4a)), the relative error is 0.5-1.5 percent for the real time interval of 10-400 s (see Fig. 2c). Finally, the nonadiabatic solution for a plate can be replaced by the adiabatic solution for a semibounded body (equation (4b)) with the error shown on Fig. 2d. In this case, we use the relation

$$T = \frac{2Q}{\lambda}\sqrt{\frac{\alpha\tau}{\pi}} = \frac{2Q}{e}\sqrt{\frac{\tau}{\pi}}.$$

Equation (5) can be used with a systematic error of less than 8 percent, which determines the trend toward a reduction of real temperature (see Fig. 2d). It is important that even in the case of the nonadiabatic condition for a plate, the dependence of T on $\tau^{1/2}$ is close to linear, as can be seen from Fig. 2b. The temperature curve departs from a straight line for an adiabatic semibounded body (equation (5) with plot of $T/\tau^{1/2}$) *only at large values of* .

Equation (5) is used below for analyzing moisture content.

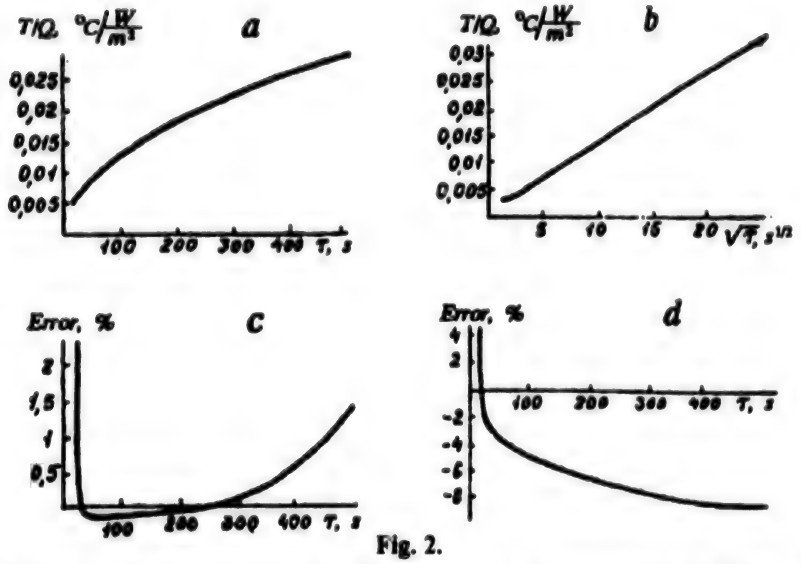


Fig. 2.

Time dependence of ratio T/Q, nonadiabatic plate 25 mm thick (a); dependence of ratio T/Q on $\tau^{1/2}$ (b); time dependence of relative temperature error, using solution for nonadiabatic semibounded body instead of nonadiabatic plate (c); time dependence of relative temperature error, using solution for adiabatic semibounded body instead of nonadiabatic plate (d)

2.2. From thermal diffusivity to moisture content

In a first approximation we assume that thermal conductivity of slightly porous bodies (brick) does not change with moisture content, at least for a low level of moisture content.

Introducing thermal inertia e for dry material and $e(W)$ for wet material, and using equations (2) and (5), we can get the following relations

$$e(W) = e\sqrt{1 + W\frac{C_в}{C}};$$

$$e(W) = \frac{2Q}{T(W)}\sqrt{\frac{b\tau}{\pi}}.$$

Table 1 summarizes values of the thermal characteristics of dry and wet bricks of San Marco type obtained on the basis of model (2).

Table 1: Thermal Properties of Brick With Different Moisture Contents

W, %	K, W/(m x K)	ρ, kg/m^3	C, J/(kg x K)	e, (W x s$^{1/2}$)/(m^2 x K)	a, 10^{-7} m^2/s
0	0.54	1510	810	813	4.42
1	0.54	1525	844	834	4.20
10	0.54	1661	1120	1002	2.90
20	0.54	1812	1372	1159	2.17

Equation (6) yields the main equation for determining moisture content

$$W = \left(\frac{4Q_{inc}^2}{\pi T^2(W)} \frac{1}{e} \tau - 1 \right) \frac{C}{C_w}.$$

Introducing the incident energy density Q_{inc} and the coefficient of absorption of the material for this energy ε, we reduce equation (7) to the following form:

$$W = \left(\frac{4}{\pi} \frac{Q_{inc}^2}{T^2(W)} \frac{\varepsilon^2}{e} \tau - 1 \right) \frac{C}{C_w}.$$

3. Error Analysis

3.1. Direct measurement of moisture content

In accordance with equation (8), direct measurement of uniform moisture content requires knowledge of: 1) the thermal properties of the dry material (e, C, ε); 2) the specific heat of water C_w; 3) incident radiation Q_{inc}.

The elevation of temperature $T(W)$ on the surface of the wet material is measured for time τ, and the value of W is found from equation (8).

Let us estimate measurement errors, assuming that the systematic errors arising due to simplifications of the model can be ignored, and that errors in assignment of the specific heat of water and time are small in comparison with other errors. Then the absolute error of measurement of moisture content can be obtained from equation (8)

$$\Delta W = \sqrt{\left[\left(\frac{\partial W}{\partial C} \Delta C \right)^2 + \left(\frac{\partial W}{\partial Q_{inc}} \Delta Q_{inc} \right)^2 + \left(\frac{\partial W}{\partial e} \Delta e \right)^2 + \right.} \\ \left. + \left(\frac{\partial W}{\partial T} \Delta T \right)^2 + \left(\frac{\partial W}{\partial e} \Delta e \right)^2 \right]$$

3.2. Measurement of moisture content by relative method

Some errors can be excluded by using dry material as a standard. From equation (5) we get

$$\frac{\varepsilon Q_{inc}}{e} = \frac{T(W=0)}{2\sqrt{\tau/\pi}}.$$

If Q_{inc} and ε are constant (homogeneous flat surface), use of the indirect method does not require measurement of the absorbed and incident energy. In this case, equation (8) is transformed to the following expression:

$$W = \frac{C}{C_w} \left(\frac{\tau_1}{\tau_2} \frac{T^2(W=0, \tau_2)}{T^2(W, \tau_1)} - 1 \right),$$

if temperature elevation was measured at different times for dry and wet specimens. If measurements were at the same time, we can use the following equation:

$$W = \frac{C}{C_w} \left(\frac{T^2(W=0)}{T^2(W)} - 1 \right).$$

Clearly, this method reduces direct measurement errors. For example, equation (9) in this case is reduced to the form

$$\Delta W = \sqrt{\left[\left(\frac{\partial W}{\partial C} \Delta C \right)^2 + 2 \left(\frac{\partial W}{\partial T} \Delta T \right)^2 \right]},$$

where the coefficient 2 comes from double temperature measurement.

4. Moisture Content Measurement System in Nondestructive Inspection

Fig. 3 diagrams the system for active thermal nondestructive inspection. An external heat source *1* (lamp, air gun, laser and the like) heats specimen *2* of thickness L. Infrared (IR) device *3* records the thermal emission of the specimen during heating and cooling, generating a halftone image of the distribution of thermal radiation. The corresponding temperature image *6* can be obtained by using algorithm of digital conversion *5* that includes such parameters as thickness L, heating power Q, absorptivity ε, emissivity E, ambient temperature T_a and thermal inertia e. In isolated cases, some parameters are not used (e.g. the thickness of the specimen when using the model of a semibounded body, or the ambient temperature and thermal inertia for a dry specimen when using the indirect method). Sometimes it is necessary to introduce other parameters (background radiation level). The next step of the main algorithm is conversion of the temperature signal *6* to thermal inertia signal *8* by using algorithm *7* based on

solving the problem of thermal conductivity. Finally, the distribution of moisture content 9 is obtained by calibrating the thermal inertia signal in units of moisture content.

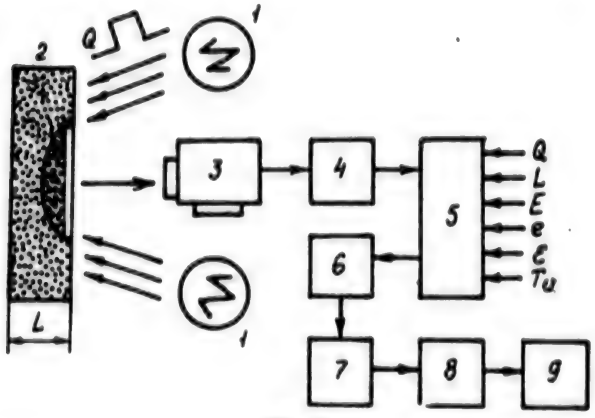


Fig. 3.

Diagram of active thermal nondestructive inspection: 1—heater; 2—specimen; 3—IR device; 4—black level regulator; 5—digital converter; 6—converter of temperature signal to image; 7—converter of temperature signal to thermal inertia; 8—module for converting thermal inertia to image; 9—module for visualizing moisture content distribution

5. Dependence of Thermal Diffusivity on Moisture Content

Up until now, we have been assuming that the thermal conductivity of the specimen does not change with changing moisture content. This assumption is not completely valid, especially for heavy wet materials.

Thermal diffusivity was measured by a pulse method to assess the effect of moisture content on the thermal conductivity of brick. Specimens of San Marco brick 8 mm thick were heated for 3 s by a 1 kW lamp. The temperature of the reverse side of the specimen was recorded by a thermocouple connected to a computer. Knowing the specific heat and density of the dry material and their behavior as a function of moisture content in accordance with equation (2), thermal conductivity can be calculated from the experimental value of thermal diffusivity.

Three methods were used for measuring thermal diffusivity from the temperature curve.

The first algorithm, proposed by Degiovanni, uses the relation

$$a = \frac{L^2}{\tau_{5/6}}\left[1{,}15 - 1{,}25\,\frac{\tau_{2/5}}{\tau_{5/6}}\right],$$

where $\tau_{2/3}$ and $\tau_{5/6}$ are the respective times at which the temperature of the specimen reaches ⅔ and 5/6 of the maximum.

The second method involves nonlinear interpolation of temperature data via a series of analytical solutions in which the thermal diffusivity is a parameter that is varied until the optimum value is selected.

The third method is known as Parker's method. The classical Parker's formula for the temperature response of the rear side of an adiabatic plate relates the so-called "half" time $\tau_{0.5}$ (when temperature raches half maximum) to thermal diffusivity as follows:

$$a = \frac{0{,}139L^2}{\tau_{0,5}}.$$

The expected value of (15) is 20 s for San Marco brick 8 mm thick. Heating duration τ_h is usually ignored if it is less than 1/10 of the half time. In our case, the following form of the equation is recommended:

$$a = \frac{0{,}139L^2}{(\tau_{0,5} - \tau_{\text{corr}})},$$

where correction time is of the order of $\tau/2$ [11].

The main difference between the described methods is associated with the conditions of the experiment. Parker's method has been suggested for adiabatic boundary conditions. Using it when there are deviations from adiabaticity may lead to errors. In this case, the other two methods are more accurate.

6. Active Thermal Inspection (ATI) of Moisture Content of Heat Insulation Coating (HIC)

Remote (from a distance of 2.5 m) ATI of moisture content was done on the HIC of plates based on foamed quartz: K = 0.05 W/(m x K), C = 840 J/(kg x K), ρ = 150 kg/m^3. Plate dimensions were 150 x 150 x 40 mm.

The thermal radiation of the specimen was recorded by an IR pyrometer with uncooled photocell. Size of the sighting area from a distance of 2.5 m was 150 x 150 mm, i.e. it was equal to the size of the plate.

A heater based on a PZS-35 spotlight in which the ordinary incandescent bulb was replaced with a miniature KGM-200-1000 W quartz halogen bulb produced a heat flux of the order of 10^3 W/m^2 on the surfvace of the HIC of the plate.

Calculations showed that the depth of heating (inspection depth) of this HIC by heat fluxes of the order of 10^3-10^4 W/m^2 for 5-10 minutes is 20-40 mm. This enables the the aforementioned one-dimensional model of heating of a semibounded body to be used for analytical investigation of the procedure for ATI of moisture content.

Table 2 for the distribution of excess temperature with respect to HIC thickness for different heating times and values of $Q = 10^3$ W/m^2, $\alpha = 10$ W/(m^2 x K) was compiled from the solution of (4a).

Table 2: Distribution of Excess Temperature $T(z, \tau)$, °C, Depthwise in HIC

z, mm	τ_h = 180 s	τ_h = 300 s	τ_h = 600 s
0	53	60	69
10	17	26	41
20	3.4	8.8	21
40	0.03	0.3	3.3

The results show that the depth of heating of the HIC at τ_h = 5 min with respect to a level of $0.1T(0, \tau_h)$ is 21 mm, and at τ_h = 10 min is 37 mm.

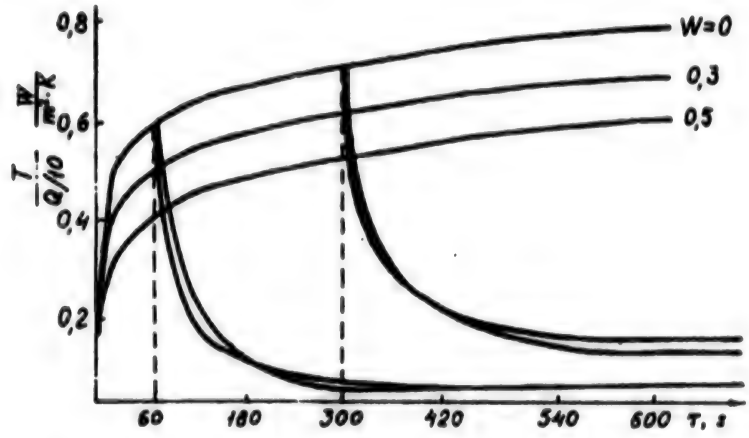


Fig. 4.
Thermograms of heating and cooling of dry ($W = 0$) and wet HIC

Fig. 4 shows thermograms of heating and cooling of dry ($W = 0$) and wet HIC. The most applicable time to check for presence of moisture in HIC is the heating segment, when thermograms show the greatest divergence. In practical realization of the procedure of remote recording of the surface thermogram of HIC heating by a pyrometer with photocell, there is a problem with background lighting of the cell by the luminous flux of the heater. This problem can be solved to some extent by using pyroelectric receivers.

The simplest method of determining the amount of moisture in a plate of HIC would be to calibrate the surface temperature at the instant of completion of heating τ_h as a function of moisture content W (41)

$$T_h = \frac{Q}{\alpha}\left(1 - \operatorname{erfc}\left[\frac{\alpha}{e(W)}\sqrt{\tau_h}\right]\exp\frac{\alpha^2\tau_h}{e^2(W)}\right).$$

However, fluctuations of heater power, heat transfer coefficients and surface absorptivity result in excessive errors when measuring absolute values of temperature. Normalization of a recorded chronological thermogram (CTG) $T(0, \tau)$ to the value of T_h excludes the influence of fluctuations of heating power and surface absorption

$$\frac{T(0, \tau)}{T_h} = \frac{1 - \operatorname{erfc}(\alpha\sqrt{\tau}/e)\exp(\alpha^2\tau/e^2)}{1 - \operatorname{erfc}(\alpha\sqrt{\tau_h}/e)\exp(\alpha^2\tau_h/e^2)}.$$

In this expression for the normalized CTG, undetermined parameters are the coefficient of heat transfer α and thermal activity $e(W) = K(W)c(W)\rho(W)$ *that depends on moisture content W.*

For a dry plate of HIC with known thermophysical characteristics, the thermal activity e of the material is known. Therefore the coefficient of heat transfer α can be determined for specific conditions of inspection from expression (18) for the normalized CTG.

By recording the CTG of a wet plate of HIC and normalizing it to the maximum value of T_h, we find the value of $e(W)$ from (18). Then by using expressions (2), we determine the amount of moisture M_w in the plate of HIC.

The values of α and e from expression (18) can be found by a simple method: from the magnitude of the normalized CTG at a certain instant. However, such single-point CTG

readings are unreliable due to fluctuations. More preferable from this standpoint are multiple-point readings that average random errors. One of the most prevalent techniques is the method of least squares. In our case, the experimentally recorded CTG was approximated by theoretical curve (18) in such a way that the sum of the squares of the differences between the theoretical and experimental curves at certain instants reached their minimum. In this procedure, the values of α and e are parameters for fitting.

Our experimental studies showed the feasibility of detecting moisture in amounts from 10 to 100 g in a plate of HIC weighing 130 g with error from 15 to 50 percent.

Conclusion

We have substantiated models of the moisture content of porous materials with allowance for dependence of all thermophysical properties on moisture content. In unilateral thermal inspection, this leads to a specific dependence of thermal inertia on moisture content, enabling reliable determination of the presence of water inside solids, and measurement of moisture content by mass. Errors of quantitative determination of moisture in this context meet practical requirements. The use of an adiabatic model for nonadiabatic conditions of an experiment leads to an overstated estimate of the value of thermal inertia.

A standard reference method is proposed for reducing the number of parameters involved. It is proposed that the effect of moisture content on thermal conductivity be evaluated on the basis of pulsed measurement of thermal diffusivity.

References

1. Caillas, C., "Thermal Imaging for Robotics Applications in Outdoor Scenes," The Robotics Inst., Carnege Mellon University. Rep. CMU-RI-TR-90, 90 pp.
2. Del Grande, N., "Airborne Detection of Buried Minefields," Energy and Technology, University of California, Lawrence Livermore National Laboratory, USA, Dec 1991, pp 9-21.
3. Grinzato, E., Mazzoldi, A., "Infrared Detection of Moist Areas in Monumental Buildings Based on Thermal Inertia Analysis," PROC. SPIE "Thermosense XII," Orlando, USA, Vol 1467, 1991, pp 75-82.
4. Granzato, E., Bressan, C., Bizon, P. et al., "Evaluation of Moisture Content in Porous Material by Dynamic Energy Balance," PROC. SPIE "Thermosense-XIV," Orlando, USA, Vol 1467, 1992.
5. Vavilov, V.P., "Qualitative and Quantitative Evaluation of Moisture in Thermal Insulation by Using Thermography," see [3], pp 230-234.
6. Baver, L.D., Gardner, W. H., "Soil Physics," N. Y., USA, John Wiley and Sons, 1972, 198 pp.
7. Hillel, D., "Soil and Water," N. Y., USA, Academic Press, 1971, 288 pp.
8. Carslow, G., Jaeger, D., "Thermal Conductivity of Solids," Moscow, Nauka, 1964, 487 pp.
9. Lykov, A. V., "Teoriya teploprovodnosti" [Theory of Thermal Conductivity], Moscow, Vysshaya shkola, 1967, 599 pp.
10. Eckert, E.G., Drake, R.M., "Analysis of Heat and Mass Transfer," N. Y., USA, McGraw Book Company, 1972, 806 pp.
11. Ivanov, A.I., Vavilov, V.P., "Analysis of Procedures of Pulsed Thermal Inspection," DEFEKTOSKOPIYA, No 1, 1987, pp 77-81.

Planning Approaches to Expanding the Bilibinskaya Nuclear Heat and Electric Power Station

957A0083A Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 9 Sep 94 pp 11-16

[Article by engineers V.F. Petrenko and A.A. Grudakov, Moscow Department, Atomenergoproyekt]

[FBIS Translated Text] Socioeconomic development of the Chaun-Bilibino zone primarily requires raising the population's standard of living, improving the ecological situation in the region, and making sensible use of and effectively developing all productive sectors that base their existence on mining industry.

Industrial exploitation of placer and bedrock tin and gold deposits by mines opened in previous years is presently continuing. As they become depleted, new ones are introduced. Thus, in addition to the continued exploitation of the Karalveyemskiy Mine of the Bilibinskiy GOK [Mining and Concentration Works], a tin mine is being created in the Pyri-Kakayskiy GOK and new productive capacities are being introduced at the Pevekskiy GOK. The possibility for developing gold mining at the Mayskoye deposit with foreign investments is under consideration. Obviously, steady and dependable operation of energy sources can guarantee successful operation of mining enterprises and normal living conditions both for the indigenous population and new personnel arriving to work at the enterprises.

The Chaun-Bilibinskaya power grid is based on three power centers referred to by their geographic locations—Pevekskiy, Bilibinskiy and Cherskiy. Each power center provides thermal power to consumers only within its administrative region, and electric power to a wider circle of consumers, including ones in the Chaun-Bilibino zone but outside the given administrative region. The three power centers are interconnected by 110 kV electric power transmission lines. The total length of the lines is 770 km.

In extreme conditions, each of the three power centers can operate independently; however, this would be associated with certain limitations upon power supply. The electric power stations making up the basis of the Chaun-Bilibinskaya power grid differ from one another dramatically.

The Chaunskaya TETs [heat and power station], which is the principal power source of the Pevekskiy power center, was built in 1944 and modernized in 1956. The installed capacity of the TETs is 40.55 MW, and its available power is 28.7 MW. The station burns coal hauled in from the Beringovskoye and Zyryanskoye deposits; annual fuel consumption is 100,00-130,000 tonnes.

The principal power source of the Cherskiy power center is the Severnoye Siyaniye floating electric power station, which has an installed capacity of 24 MW and operates under peak-load conditions. The station is equipped with two DO-14 gas turbine units that may operate with both gas and diesel fuel. The station equipment is operated 1,500 hours annually; relative fuel consumption is rather high—over 575 gm/kWt and annual consumption is around 15,000 tonnes. Fuel is delivered from the Nakhodka tank farm via the Northern Sea Route over a distance of 6,360 km. The electric power station was placed into operation in 1970, and its planned operating life is 30 years.

The main power source of the Bilibinskiy central power facility is an ATETs [nuclear heat and electric power station] of the same name with an installed capacity of 48 MW. The station operates under base load conditions, and it is utilized 7,000 hours annually. The ATETs, which has an adjustable power output, may operate at capacities down to 50 percent of nominal. The Bilibinskaya ATETs is the main power source for the entire region under consideration here. Its share of the total capacity of all power sources of the Chaun-Bilibino zone is 42.6 percent, and annual power generation is around 60-70 percent of the total. The ATETs was placed into service in 1974, and consequently, considering the 30-year life set by regulations for nuclear power stations, the station's first two power blocks must be retired in 2004. Nuclear fuel is delivered to the ATETs by air transportation landing at Keperveyem Airport, which communicates with the ATETs by a motor highway around 40 km long open for 24-hour use. The unit mass of the carried fuel permits its transportation by ordinary vehicles available at the station.

Besides the listed power sources in the region, there are around 550 small isolated diesel electric power plants and numerous boiler plants burning imported liquid and solid fuel. High relative fuel consumption and the high cost and laboriousness of fuel delivery make it necessary to replace these sources and connect consumers to centralized power supply grids.

Because the principal power sources of the Chaun-Bilibino zone will exhaust their design operating life in the not-too-distant-future, as is evident from the above, the need has arisen for finding ways to replace the retiring power capacities. The following alternative solutions to the problem were examined:

- erecting a gas turbine unit in the settlement of Pevek and a boiler plant burning solid fuel in the settlement of Bilibino;
- building a coal TES [thermal electric power station] in Pevek and a solid-fuel boiler plant in Bilibino;
- erecting the second generation of the Bilibinskaya ATETs.

It was concluded on the basis of a feasibility comparison of these variants that it would be suitable to build a nuclear heat and power station in Bilibino, an idea that had already been substantiated earlier in the feasibility study on expanding the existing Bilibinskaya ATETs. This will make it possible to reach both objectives associated with power per se, and ecological, social, and economic objectives, the principal ones of which are:

- replacing retiring capacities in the Bilibinskiy power center;
- covering the heat and electric loads of consumers supplied by the Bilibinskiy power center by supplying power to the Chaun-Bilibinskaya power grid;
- building a high-capacity centralized heat supply source directly within the zone of maximum concentration of heat loads;
- reducing consumption of fossil fuels, and by doing so, reducing environmental pollution resulting from operation of the station and transportation of fuel to the facility;
- cutting back shipments of fossil fuel far into the continent's interior;
- raising power consumption by the local population to a level corresponding to modern requirements;
- creating a possibility for utilizing the existing construction industry base to build the ATETs.

The new station in Bilibino is planned with three blocks. Each power block will contain the following basic equipment: an ATU.2 reactor with a heat output of 125 MW, a KT-40/32-6.4 turbine, and a TF-50 turbogenerator.

The total output of the three power blocks of the ATETs (the second generation) operating under different modes is shown in the table.

Operating Mode	Produced Output, MW	
	Electric	Thermal
Condensation	120	-
Heat-extraction 1	96	104.7
Heat-extraction 2	78	174

The ATU.2 reactor, which is a safe and ecologically clean power source, is intended for acquisition of saturated steam used to generate electric and thermal energy. The merits of the reactor include the ability to vary its

output, dependability and simplicity of operation, earthquake resistance, and ease of delivery of components to the construction site.

The ATU.2 reactor includes:[1] a TVGYe.2 water-cooled graphite-moderated reactor with tubular fuel elements; a natural-circulation heat transfer agent loop consisting of a separator and up, down, and other pipes; systems and equipment providing for normal operation and safety of the reactor. The basic characteristics of the reactor are presented below:

Reactor thermal output, MW	125
Steam productivity, tonnes/hr	216
Steam pressure in separator, MPa	6.7
Steam temperature, °C	283
Total fuel load (UO_2),tons	13.2
Number of reactor fuel channels	520

While generally based on the same concept, the TVGYe.2 reactor differs from its prototypes operating at the Beloyarskaya AES and the one operating at the Bilibinskaya ATETs in possessing greater output, improved technical and economic indicators, and higher safety.

Use of tubular fuel elements is responsible to a significant degree for the high operating characteristics and safety of the reactor, including absence of radioactivity in the heat transfer agent, dependable operation during rapid changes in output, and good thermal contact with the graphite pile, which ensures the necessary heat transfer from the graphite under normal operation and in accidents. The fuel in the fuel elements is composed of a magnesium matrix containing uranium dioxide, and the jackets (inner and outer) are made of steel. A fuel assembly consists of six fuel elements.

Natural circulation of the boiling heat transfer agent throughout the entire range of variation of output made it possible to simplify the circulation scheme, which in turn helps to raise the dependability and safety of the reactor and reduce operating expenses. Owing to natural circulation of the heat transfer agent, additional failures are excluded and fluctuations in the temperatures of reactor components during rapid changes in output decrease, which ensures dependable work of the reactor in the presence of changing loads.

High safety of the ATU.2 reactor is achieved owing to highly developed internal reactor safety systems and the principle of multiple protection.

The basic properties of internal protection inherent to the reactor are determined by technical concepts embodied in the plan of the ATU.2 reactor. In view of physical and chemical qualities and laws typical of the fuel, of the heat transfer agent, and of other components of the core, negative reactive feedbacks are created, such that the reactor undergoes self-limitation of output or self-stoppage in the event of failure of all active reactivity controls in accidents associated with disruption of heat transfer.

Under normal operating conditions, when equipment fails the nuclear fuel is cooled passively by the heat transfer agent's natural circulation, and if the heat transfer agent drops out of the picture, the fuel is cooled due to the good thermal contact of the tubular fuel elements with the graphite pile, which is distinguished by high heat capacity and thermal conductivity (exclusion of the possibility of damage to the fuel elements in all anticipated and unanticipated accidents beyond the maximum design limit makes it possible to do without additional emergency heat transfer channels).

If leaking occurs in the pipelines and equipment of the natural circulation loop, release of radioactive substances is insignificant, and they do not present any danger to the population or station personnel owing to use of tubular fuel elements that ensure absence of radioactivity in the heat transfer agent.

The principle of multiple protection presupposes creation of a succession of protective barriers to the spread of radioactive materials and implementation of measures directed at defending these barriers. The plan for the ATU.2 reactor foresees the following physical barriers serving to contain accidents:

- a jacket over the dioxide fuel, and a magnesium matrix;
- the jackets of the fuel elements;
- pipelines and equipment of the first loop;
- the metallic structure forming the reactor space;
- an accident containment system breaking up the fuel channels in the reactor space;
- a protective leakproof shell.

The plan of the reactor also foresees use of physically independent systems based on different principles of operation and serving to control the reactor's output, to stop it, to cool the nuclear fuel and to maintain design pressure in the natural circulation loop and reactor space with the purposes of protecting these barriers.

The low radioactivity of the heat transfer agent in the natural circulation loop made it possible to use a simple single-loop system for the power block (Figure 1), which helped to reduce outlays on thermomechanical equipment and simplify its operation, and permitted exclusion of additional failures.

Water from the separator descends through down pipes into the reactor core, where it partially evaporates. The steam-water mixture then rises back into the separator. Steam from the separator is fed to the turbine, and after the turbine, to the condenser. The resulting condensate is directed through heaters into a deaerator, from which it is returned to the natural circulation loop by feed pumps.

The KT-40/32-6.4 steam condensing turbine (with unregulated steam pressure at the bleed-offs), which

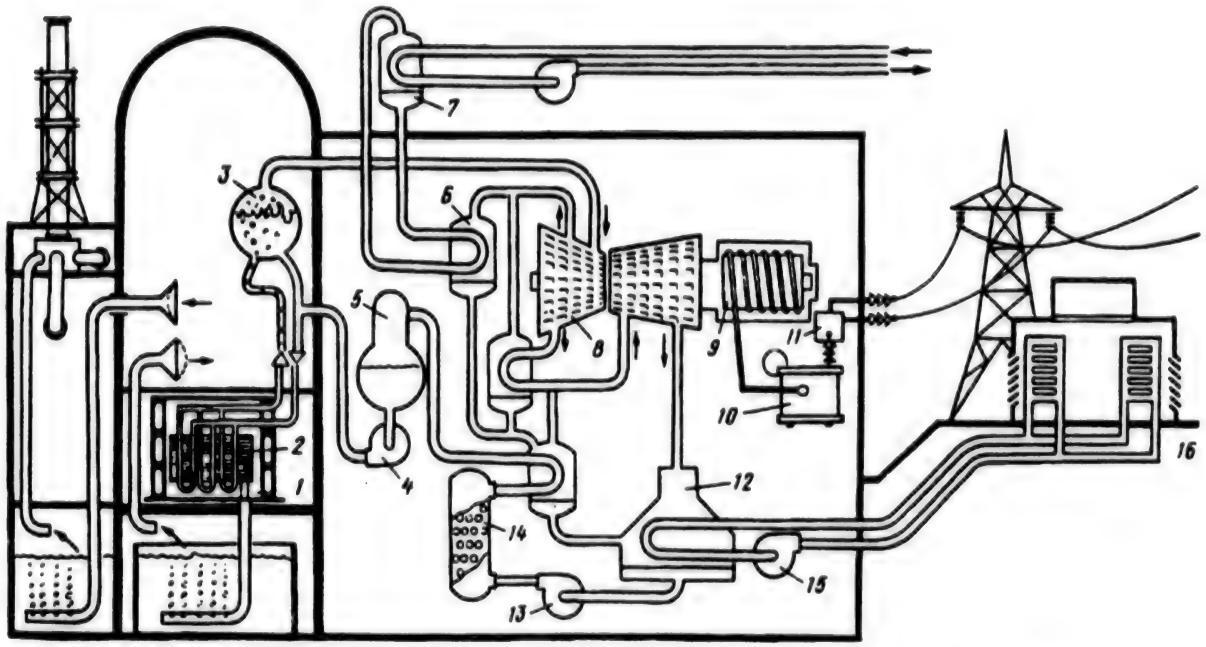


Figure 1. Rough Diagram of the Power Block: 1—TVGYe-2 reactor; 2—reactor core; 3—steam separator; 4—feed pump; 5—deaerator; 6—heat exchangers of intermediate heat supply system loop; 7—combined separator and steam heater; 8—KT-40/32-6.4 turbine; 9—TF-50 generator; 10—transformers; 11—110 kV factory-assembled SF_6 gas switch-gear; 12—turbine condenser; 13—condensate pump; 14—condensate purifying unit; 15—industrial water circulating pump; 16—air coolers

operates at 3,000 rpm, is intended to drive a TF-50 turbogenerator with an explosion- and fire-safe design. Heat is picked off from the condensers with industrial water that is cooled in air-cooling radiators.

In accordance with the power block's thermal scheme, heating water is heated by steam from the turbine's unregulated bleed-off (in heat-extraction mode). To avoid even the slightest radioactive contamination of the heating water, an intermediate loop is foreseen for its heating.

The main reactor equipment, the fuel loading devices, the reactor spent fuel storage site and the accident containment tank are accommodated inside the protective leakproof shell, which is intended to protect the reactor from external influences and limit the consequences of unanticipated accidents. The equipment and rooms inside the reactor compartment are equipped with discharging units in order to protect against excess pressure during accidents. Part of the reactor auxiliary equipment and the rest of the power block equipment are located (in a modular arrangement) within the structure surrounding the shell.

The main and auxiliary buildings and structures of the second generation of the Bilibinskaya ATETs are located at several sites.

The industrial sight of the second generation of the Bilibinskaya ATETs, which consists of two sites (No 1 and No 5), is east of the settlement of Bilibino, on the right bank of the Bolshoy Ponneurgen River, and it communicates with the settlement by a motor road.

The existing reservoir on the Bolshoy Ponneurgen River is undergoing reconstruction, and it is being used as the water supply source for the settlement of Biiibino and the Bilibinskaya ATETs.

The main production facilities of the second generation of the Bilibinskaya ATETs (Figure 2) are: the main block, containing the reactor rooms of power blocks No 5, No 6 and No 7, the deaerator structure, the machine room, an indoor switch-gear (common to the three power blocks), a block housing general station systems, an engineering and laboratory block, a special-process block, the spent fuel storage site, the gas system block, back-up diesel-electric stations, the start-up and back-up boiler room, air-cooling radiators, and transportation and production galleries.

The main block is directly adjacent to the general station system block and the engineering and laboratory block. Besides laboratories and shops, the engineering and laboratory block contains personal amenity rooms and medical checkpoints for all personnel working in the restricted area, and administrative services. Buildings of

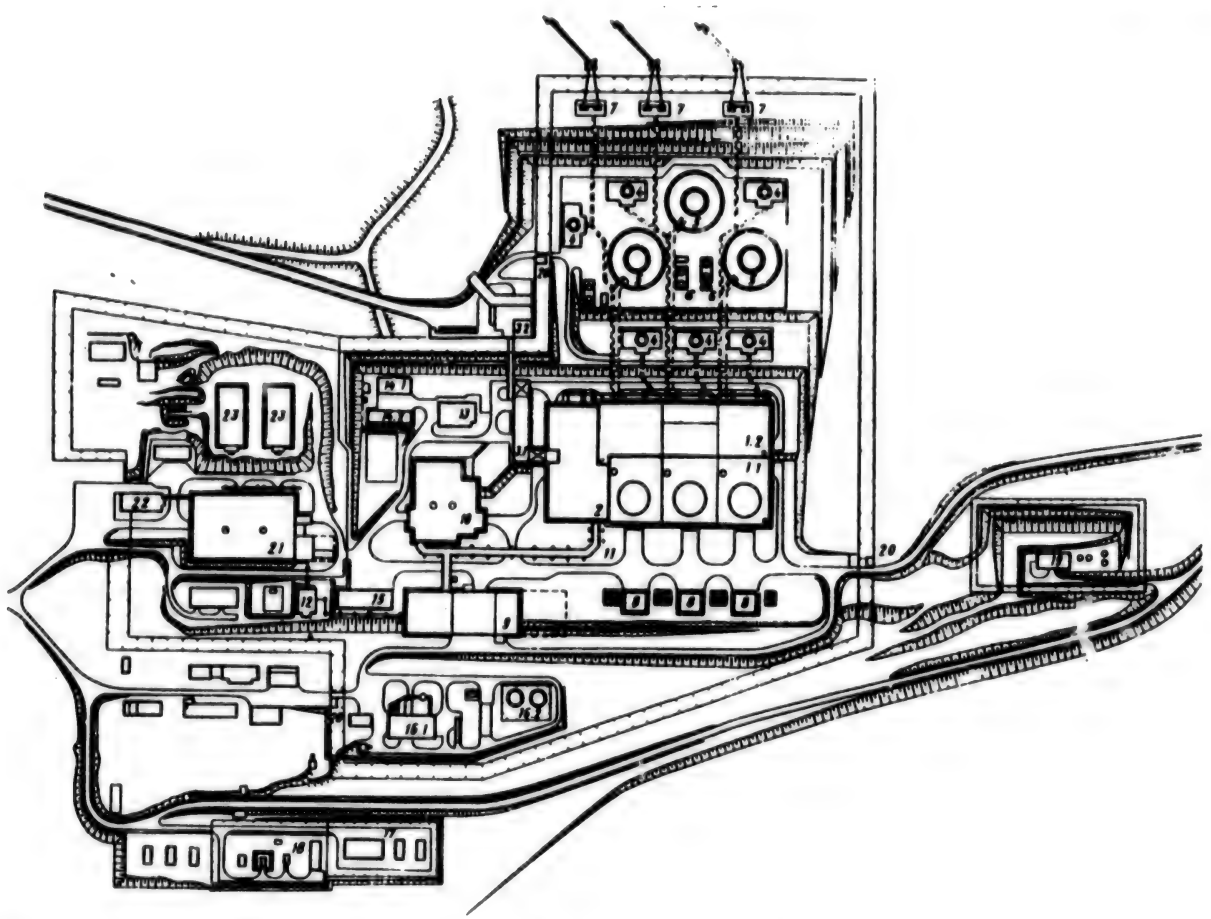


Figure 2. General Layout of the Bilibinskaya ATETs: 1.1—reactor room and deaerator structure; 1.2—machine room and factory-assembled switch-gear department; 2—general station system block; 3.1—laboratory and personal amenity block of engineering and laboratory block; 3.2—administrative and visitor reception block of engineering and laboratory block; 4—safety system air-cooling radiators; 5—normal operating system air-cooling radiators; 6—peak-load cooling towers; 7—cable to power line transition point; 8—block back-up diesel-electric power station; 9—special-process block; 10—spent nuclear fuel storage; 11—transportation and production gallery; 12—liquid radioactive waste storage; 13—gas system block; 14.1—ATETs security building; 14.2—eight-car garage; 15—special vehicle garage; 16.1—start-up boiler building; 16.2—fuel oil storage; 17—sewage treatment plant; 18—rainwater and production waste treatment plant; 19—combined water pipeline structures block; 20—checkpoint; 21—main block of the first generation of the Bilibinskaya ATETs; 22—ABK [not further identified] of the first generation of the Bilibinskaya ATETs; 23—air-cooling radiators of the first generation of the Bilibinskaya ATETs

the main block communicate by a heated transportation, communication and pedestrian gallery with the special-process block, where radioactive wastes are processed and stored, and with the spent nuclear fuel storage building. This layout of the facilities ensures comfortable conditions for operating personnel, which is especially important in the Far North, as well as a compact building arrangement and simpler utility lines. In addition the concentrated location of medical checkpoints and other nonproductive services makes it possible to minimize the possibility of spreading radioactive materials outside the ATETs.

In accordance with the requirements of public health regulations (SP AS-88), the rooms of buildings and structures within the composition of the main block, the medical checkpoints and the spent nuclear fuel storage building are divided into restricted and unrestricted areas. Movement from the restricted area into the unrestricted area is possible only through the medical checkpoints.

Rooms in which constant presence of personnel is foreseen (block control panels, block duty personnel rooms) are separated out as an isolated zone that communicates with other rooms in the restricted area only through a

medical examination lock equipped with a radiation monitoring system, which should guarantee the radiation "cleanliness" of these rooms.

The building housing the reactor room (Figure 3) of each power block, which contains the reactor as well as the safety system, the fresh and spent nuclear fuel storage and transportation system, the "dirty" water processing system and the block operational control system, has a monolithic prefabricated reinforced concrete design, and its plan dimensions are 57x51 m. The central cylindrical part of the building, topped by a 30 m diameter dome, is a leakproof barrier able to contain accidents, including unanticipated ones. The cylindrical part of the building is surrounded by reinforced concrete structures. These structures and the cylindrical part comprise a single structural volume (with the shape of a cube) topped in its central part by a dome. All possible (and practically impossible) external effects, including a shock wave with a frontal pressure of up to 10 MPa, an eight-point earthquake, hurricanes, and the load created by the impact of a falling airplane, were accounted for in developing the structural concepts of the reactor buildings, the spent nuclear fuel storage building and the special-processes block.

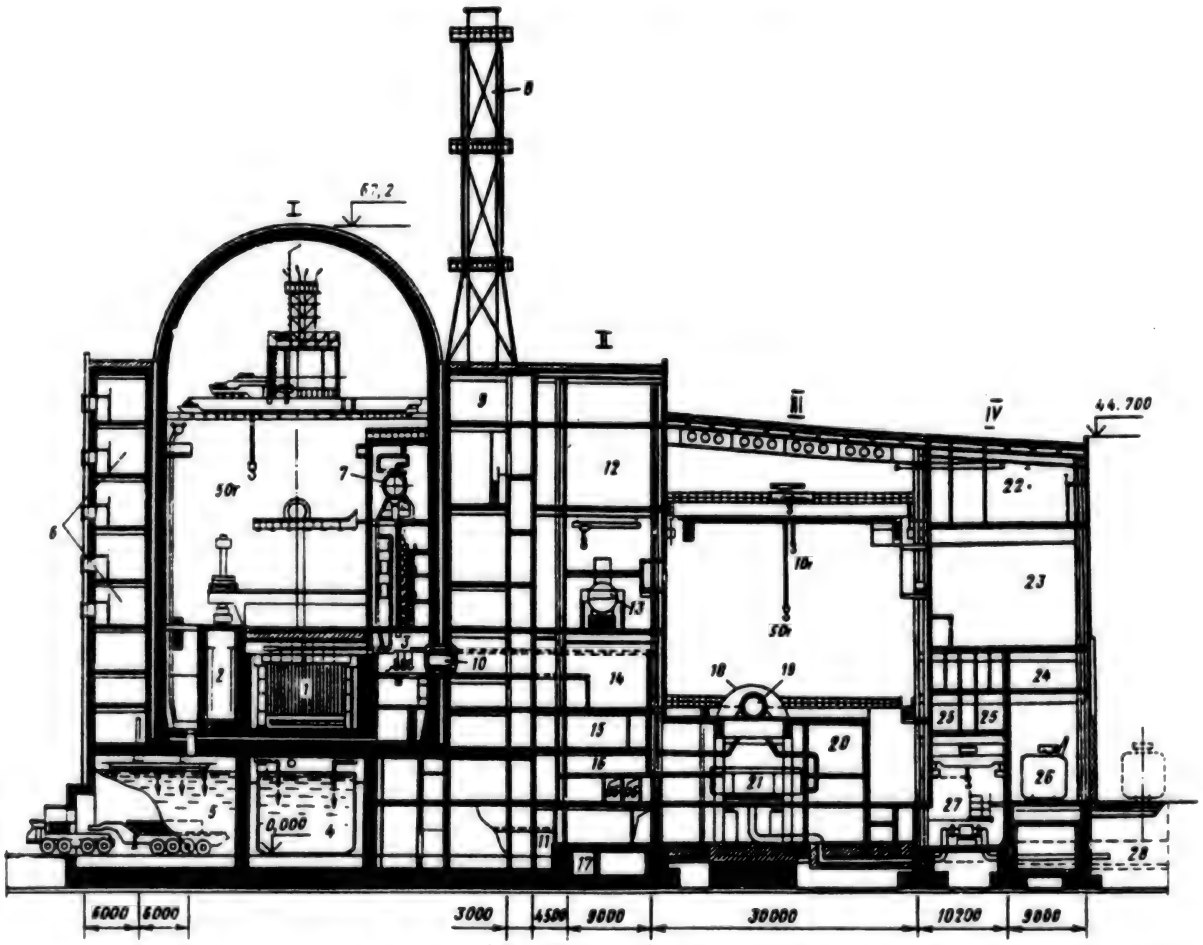


Figure 3. Cross Section of the Main Block of the Second Generation of the Bilibinskaya ATETs: I—reactor compartment; II—deaerator structure; III—machine room; IV—factory-assembled switch-gear department; 1—TVGYe-2 reactor; 2—reactor spent nuclear fuel storage; 3—SUZ [not further identified] drives; 4—accident containment tank; 5—bubbling tank; 6—reactor plenum ventilation centers; 7—steam separator; 8—stack; 9—reactor exhaust ventilation center; 10—leakproof lock; 11—"clean" pipeline corridor; 12—deaerator structure exhaust ventilation center; 13—deaerator; 14—communication corridor; 15—electrical engineering rooms; 16—cable rooms; 17—"dirty" pipeline corridor; 18—KT-40/32-6.4 turbine; 19—YeUZ [not further identified] TVF-63-2 generator; 20—turbine plant box; 21—turbine condenser; 22—plenum ventilation center of factory-assembled switch-gear department; 23—110 kV factory-assembled switch-gear; 24—gas pipeline corridor; 25—cable rooms; 26—transformer boxes; 27—industrial water circulating pump; 28—industrial water pipeline tunnel

The rest of the buildings of the main block and structures within the composition of facilities on the industrial site are planned as industrial buildings and structures, and they have their own unique features associated with the production operation.

The following data attest to the increased safety of the nuclear power station. When all three power blocks are operating under normal operating conditions, the radioactivity of atmospheric exhausts does not exceed 0.02 milliroentgens/hr, which corresponds to the natural radiation background in this region. In case of accident, all radioactive releases are contained within the protective leakproof shell. Accidents involving rupture of the fresh steam line located outside the protective shell are an exception. But even in this case, according to the calculations the external gamma-radiation dose at the boundary of the health protection zone would not exceed 0.004 Sv/year (0.4 rems/year), which is significantly below the maximum permissible indicator, equal to 0.1 Sv/year (10 rems/year).

In view of the complex climatic conditions in which the station is located and the great difficulties involved in evacuating the public in case of accident, the planners of the second generation of the Bilibinskaya ATETs were given the task of creating a nuclear power station with heightened safety, and provide for a probability of severe damage to the core at a level of 10^{-6} per reactor-year (the permissible value established in the OPB-88 [not further identified] is 10^{-5}) and a probability of a maximum accidental release excluding the need for evacuation of the public of 10^{-8} per reactor-year (10^{-7} according to the OPB-88). The probability safety analysis submitted together with the project materials showed that owing to use of a reactor with highly developed internal self-protection properties, effective accident containment systems and different types of safety systems, these indicators could be reduced to 10^{-7} and 10^{-9} respectively. This provides the grounds for classifying the second generation of the Bilibinskaya ATETs as a nuclear power station of heightened safety.

The basic technical and economic indicators of the Bilibinskaya ATETs (the second generation) are presented below:

Sustained output, MW:	
thermal	375
electric	120
Annual number of hours of use of sustained output	6,900
Annual generation of:	
electric power, thousands of kWr	599,760
thermal energy, GJ	3,468,564
Standard construction time, months:	
until start-up of first power block	120
until start-up of third power block	144
Number of production personnel	987

The design developments show that erection of the second generation of the Bilibinskaya ATETs, which is a safe and ecologically clean energy source, will make it possible to successfully solve the problem of covering the thermal and electric loads of consumers of the Chaun-Bilibinskaya regional power grid.

Footnote

1. A detailed description of the reactor is given in the article "The Heightened-Safety ATU.2 Reactor" by A. I. Alekseyev, V. I. Mikhan et al., published in ENERGETICHESKOYE STROITELSTVO, No 4, 1994.

Basic Directions of Planning Nuclear Power Stations With Heightened Fire Safety

957A0083B Moscow ENERGETICHESKOYE STROITELSTVO in Russian No 9 Sep 94 pp 17-20

[Article by engineers A.A. Grudakov and Yu.V. Todres, Moscow Department of the Atomenergoproyekt]

[FBIS Translated Text] Nuclear power stations are included among production operations of heightened fire danger in view of the presence of certain buildings and structures in nuclear power stations containing sizable quantities of flammable materials. The main sources of fire danger are: power and control cables with flammable insulation; hydrogen used in the generator cooling system; transformer and lubricating oils; computer center rooms, etc.

According to foreign specialists the probability of major fires not causing a decrease in the safety of a nuclear power station is 10^{-1}-10^{-2} per station per year [1].

However, as the results of observations made in 1980-1988 show, the intensity of fires at nuclear power stations with output capacities of 800 MW and more operating in CIS countries attained the following values in certain zones (per reactor-year) [2]:

Reactor room	1.80^{-1}
Main block machine room	1.70^{-1}
Deaerator structure	3.20^{-2}
Special process block	7.90^{-3}
Auxiliary system rooms	5.10^{-2}
Cabling	1.20^{-1}
Including cabling of safety systems	1.60^{-2}
Electrical engineering devices	1.50^{-1}
Turbogenerators	6.30^{-2}
Primary circulating pumps	2.40^{-2}

Such high indicators for the probability of fires at nuclear power stations, the consequences of which manifest themselves not only on a regional but also an interregional level, make development and successive implementation of effective fire protection measures extremely urgent.

In view of the fact that development of such incidents at nuclear power stations may lead to an unanticipated accident, ensuring fire safety must be viewed as one of the directions for raising the overall safety of nuclear power stations, the end goal of which is to prevent or reduce an accident's radiation consequences to the population and the environment.

Fire protection measures at nuclear power stations reduce to creating passive and active fire protection, which must be included when buildings or rooms contain flammable materials with thermophysical properties presenting a fire danger. The types of fire protection indicated above differ fundamentally in purpose: passive—preventing a fire, and containing it if it arises; active—fire suppression (and as a consequence, prevention of a fire's destructive consequences leading to great material loss).

Passive protection is achieved by implementing the following measures:

- dividing buildings into separate fire protection zones (the main requirement imposed on a fire protection zone is prevention of the spread of fire to neighboring rooms or a neighboring zone);
- minimizing the volume of flammable materials used at a station, and when possible, replacing flammable materials by fire-resistant and/or nonflammable materials;
- adopting space and layout concepts ensuring enclosure of rooms by structures having the required fire resistance (depending on the category of rooms in terms of explosion-and-fire and fire danger), and locating flammable materials fire-safe distances apart (in the USA [3], a horizontal distance of over 6 m is considered to be a fire-safe location of safety channels of a nuclear power station).

Active fire protection includes water, gas and aerosol fire extinguishing systems.

Water fire extinguishing systems have enjoyed the greatest use at nuclear power stations, which is explained both by properties of water (owing to its high penetrating capacity, effective fire suppression is ensured while simultaneously cooling structures and production equipment), and its low cost. When use of water to extinguish a fire is impermissible (in view of special properties of the burning substance or material), gas (CO_2, nitrogen) or foam is used in place of it for these purposes. Gas and foam fire extinguishers operate automatically as a rule.

Fires are put out with water by means of a station-wide fire extinguishing system, which in most nuclear power stations supports many functions (Table 1).

Table 1

Function of Station-Wide Fire Extinguishing System	Water Flow Rate Symbol, liters/sec	Firefighting Equipment Employed				
		Fire Cocks	Hydrants	Fire Monitors	Drenchers (Fog Sprayers)	
					Automatically Started	Manually Started
Interior fire suppression	q_{in}	+	-	-	-	-
Exterior fire suppression	q_{ext}	-	+	-	-	-
Fire suppression in cable structures of systems for normal operation	q_1	-	-	-	+	-
The same, for safety systems	q_2	-	-	-	+	-
Fire suppression of transformers and their oil coolers*	q_3	-	-	-	+	-
Flooding (cooling) of turbine main oil tanks	q_4	-	-	-	-	+
Flooding (cooling) of metallic girders in machine room	q_5	-	-	+	-	-
Fire suppression of oil equipment** of electric feed pumps or primary circulating pumps	q_6	-	-	-	+	+

*When transformers are located in closed boxes, it would be suitable to use a foam fire extinguisher (given an appropriate feasibility study).

**When located in a room with a large structural volume in which it is impossible to precisely locate a fire, manual starting is recommended.

In cases where a fire occurs in cabling of the safety system, and more than one safety channel may fail, automatic fire extinguishers and the fire alarm are the supporting systems, and the fire extinguishing system of this equipment is organized according to the local principle [4]. The layout of the systems and recommendations on determining their required reliability are presented in [2].

Water flow rates q_{in} and q_{ext} are adopted in accordance with [4] and [5], while q_1-q_6 are established by special calculations.

The number of simultaneous exterior fires depends on the area of the nuclear power station's industrial site, and it is regulated by [5]. Planning experience shows that the area of the industrial site of a multiblock station does not exceed 150 ha. In this case the standard number of simultaneous exterior fires is equal to unity.

In accordance with recommendations of international guidelines [6], simultaneous unrelated fires at two or more power blocks should not be considered when determining the number of simultaneous fires at stations possessing several power blocks.

When calculating the operating parameters of equipment within the composition of the station-wide fire extinguishing system and of the system as a whole, two modes (states) of the station-wide fire extinguishing system must be considered: mode I—"Waiting," mode II—"Fire Suppression."

In cases when the system is in "Waiting" mode, pressure supporting the work of two fire cocks with a flow rate q_{in} must be constantly maintained within it. In this case the pressure head in the station-wide fire extinguishing system must be sufficient to operate the most distant and highest fire cock.

The design water flow rate in mode I is equal to q_{in}:Q_I=q_{in}.

We will examine the "Fire Suppression" mode in greater detail, inasmuch as this question is not illuminated in currently effective technical standards.

The unique operating conditions of the station-wide fire extinguishing system in this mode at a nuclear power station are the result of simultaneous use of different types of fire suppression, which ultimately determines the design productivity of the station-wide fire extinguishing system.

The design water flow rates for mode II are given in Table 2.

Table 2

Type of Fire Suppression	Formula for Determining Design Flow Rate, liters/sec	Mode Justifying Source
Exterior and interior	$Q^1_{II}=q_{ext}+q_{i\ n}$ (1)	[4,5]
Exterior and interior fire suppression and suppression of transformer fires with fog	$Q^2_{II}=0.25q_{ext}+q_{in}+q_3$ (2)	[4,5]
Exterior and interior fire suppression, suppression of fires in cabling of systems for normal operation*	$Q^3_{II}=q_{ext}+q)in+q_1$ (or q_2) (3)	[4,5]
Suppression of fires in cabling of safety systems**	$Q^4_{II}=q_2$ (4)	[4]
Suppression of fires in machine room (check mode)	$Q^5_{II}=q_{in}+q_4+q_5$***$+q^{EFP}{}_6$ (5)	Operating experience

*If the automatic fire extinguisher servicing cabling of the safety system is classified as supporting normal operation, the larger of the flow rates q_2 or q_1 is entered into (2).

**If the automatic fire extinguisher servicing cabling of the safety system is classified as a safety system, a special firefighting water line is created for it [4].

***The water flow rate is established on the condition that not less than one girder is flooded by two monitors.

To support the indicated types of fire suppression at a nuclear power station, the station-wide fire extinguishing system is designed to include a firefighting high-pressure water line, the maximum head of which must not exceed 90 m (providing normal operation of fire hydrants and interior fire cocks).

It should be considered that the height of the reactor room may be larger than that of the rest of the rooms of the main block and of other buildings on the site of the nuclear power station. In this case installation of a zonal water line is recommended for the upper part of the reactor room.

The firefighting pumping station of the station-wide fire extinguishing system consists of two groups of fire pumps, one of which supports the "Fire Suppression" mode, and the other the "Waiting" mode. The delivery of pumps in the first group is calculated on the basis of the larger flow rates in formulas (2) and (3), and it is checked for correspondence with the design flow rate Q^5_{II} (5).

In cases when the automatic fire extinguisher of the safety system is classified as a safety system, its design should be based on requirements regulated in [4] and [7].

Gas fire extinguishers using carbon dioxide or nitrogen as the fire suppressant are employed in radioactive waste storage facilities for fire protection of boxes containing solid radioactive wastes capable of spontaneous combustion (oily rags, overalls).

In rooms containing electronic apparatus and switching panels, firefighting foam is enjoying increasingly greater use for these purposes in place of highly scarce and ozone-degrading refrigerants.

Proper selection of the resources of passive and active fire protection and their optimum combination make it possible to dramatically enhance the fire safety of nuclear power stations.

A typical example of a nuclear power station with heightened safety is the second generation of the Bilibinskaya ATETs, the plan of which was developed in 1993 by the MO AEP [not further identified]. The second generation contains three ATU.2 reactor units equipped with TVGYe-2 reactors with a thermal output of 125 MW each and an electric output (when operating in condensation mode) of 40 MW each.

In accordance with IAEA recommendations the building of the main block is divided into separate firefighting zones: the reactor room, the deaerator structure, the machine room, the factory-assembled switch-gear department, and the station-wide system block.

The reactor room is separated from the rest of the rooms of the main block by fire walls with degree I fire resistance having a fire resistance limit of 2.5 hours (type I fire walls according to [8]).

The machine room is also separated from the rest of the rooms by type I walls. The fire walls of the station-wide system block and of the factory-assembled switch-gear, which offer degree II fire resistance, have a fire resistance limit of 2 hours.

A number of measures directed at ensuring the station's radiation safety and simultaneously serving as passive fire protection resources are foreseen in the production part of the plan for the second generation of the Bilibinskaya ATETs:

- The interior reactor space is sealed off, and in order to reduce burn-out of graphite at high temperatures (up to 700°C), it is filled with nitrogen under excess pressure equal to 200 MPa (considering the phlegmatizing properties of nitrogen, this approach should be interpreted as an effective means of passive protection);
- there is a protective leakproof reinforced concrete shell with a fire resistance limit above 2.5 hr.

In order to ensure fire safety, the cable lines of safety channels I and II and of the normal operating systems,

located in the reactor compartment, are separated horizontally by a distance exceeding 30 m. These cable lines are laid basically in impassable shafts and partially in accessible galleries. The enclosing structures of the shafts and galleries have a fire resistance limit of 1.5 hr. Owing to these measures the possibility of a fire spreading from one line to another is excluded, thus raising the overall safety level.

Fire safety at the ATETs is determined to a significant degree by the effectiveness of passive protection adopted for the machine room. Considering that normal operating systems important to the safety of the ATETs are located in the machine room, this part of the buildings of the main block are categorized as having degree I fire resistance in accordance with [4], requiring erection of columns of the metallic frame with a fire resistance limit of 2.5 hr, and application of a layer of brand OVP fire-resistant compound 3.2 mm thick over metallic roofing beams, which ensures a beam fire resistance of 0.75 hr.

Planning approaches directed at minimizing the quantity of flammable materials in the machine room are also treated as passive fire protection measures. Thus, the Novosibirsk Sibelektrotyazhmash Plant developed the 40 MW TF-50 turbogenerator on the basis of an order from the MO AEP. This turbogenerator is unique in that the generator is air-cooled (in place of hydrogen cooling), and bearings are lubricated with fire-resistant brand OMTI oil. OMTI oil is also used in the turbine lubricating and regulating system, developed by the POAT KhTZ [not further identified]. These and other concepts made it possible to minimize the amount of flammable materials in the machine room, and consequently the probability of fire.

As a supplement to passive protection measures for the Bilibinskaya ATETs, active fire protection was foreseen, including water, gas and foam fire extinguishing systems.

Creation of a single station-wide fire extinguishing system common to all three power blocks was foreseen for the purposes of exterior and interior fire suppression, suppression of fires in cabling with fog, and flooding (cooling) of machine room girders. The basic diagram of this system is shown in the figure.

Because the cabling of the safety system of the main block of the ATETs is separated to a fire-safe distance, as was indicated above, the automatic fire extinguishers protecting these structures are classified according to [4] and [7] as systems supporting normal operation, and they are included as part of the station-wide fire extinguishing system.

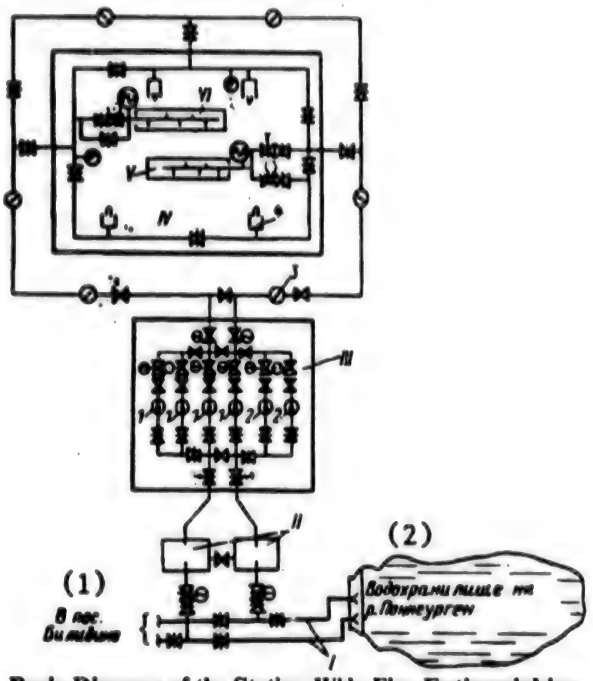
The design flow rates of water from the firefighting reservoir of the station-wide fire extinguishing system corresponding to the possible operating modes of the system are adopted as follows [4,5]:

in "Waiting" mode:

$$Q_{II}=q_{in}=10 \text{ liters/sec};$$

in "Fire Suppression" mode:

$$Q^3_{II}=q_{ext}+q_{in}+q)nf1=50+10+42=102 \text{ liters/sec};$$



Basic Diagram of the Station-Wide Fire Extinguishing System: 1—main fire pumps; 2—pumps maintaining pressure in firefighting water line network; 3—fire hydrant; 4—stationary fire monitors; 5—fire cock; I—water main; II—firefighting water reservoirs; III—pumping station of station-wide fire extinguishing system; IV—main block; V—safety system cabling; VI—cabling supporting normal operation

Key: 1—to Bilibino settlement; 2—reservoir on Ponneurgen River

in check mode: $Q^5_{II}=q_{in}+q_5=10+76=86$ liters/sec (the second term is determined from the condition that each of two metallic girders is cooled by two monitors—that is, $q_5=4x19=76$ liters/sec).

In view of the use of fire resistant brand OMTI oil, cooling of the main oil tanks of the turbines is not foreseen, and flow rate q_4 is omitted from formula (5). Also omitted from this formula is flow rate q^{EFP}_6, owing to use of oil-bath lubrication of the bearings of electric feed pumps with negligible oil consumption (within 3 liters over the course of 8,000 hours).

Water is to be supplied to the ATETs for firefighting purposes from the station's water main, which takes water from a reservoir on the Ponneurgen River. The water flows from the water main to the back-up fire reservoir, from which it is fed by pumps of the fire station to the firefighting water pipeline ring passing both over the outside surface (where it is paired with a heating pipe) and inside the machine room of the main block of the ATETs.

Two groups of pumps are installed in the fire pumping station. The first group of pumps (working and back-up) maintain constant pressure in the firefighting water pipeline network, while the second (two working and two back-up) are intended for use in "Fire Suppression" mode.

It should be noted that each safety system automatic fire extinguishing unit connected to the firefighting water pipeline ring within the machine room is equipped with two shut-off and start-up devices in order to raise operating reliability, and a separating gate valve is installed on the water main at the point of connection of the feed pipelines, to ensure delivery of water to the involved room from two sides.

Boxes for storage of soft radioactive wastes (rags, overalls) capable of spontaneous combustion are equipped with gas fire extinguishers utilizing CO_2 as the fire suppressant.

A foam fire extinguishing system suppressing fires involving a large area is foreseen for the sealed transformer boxes, for rooms containing electronic and electrical engineering apparatus, and KRU [not further identified] rooms. Such systems successfully replace refrigerant gas fire extinguishing systems employed for similar purposes.

The main operating component is the firefighting foam generator producing foam containing self-activating fire extinguishing compounds. The gas-aerosol mixture produced by the firefighting foam generator (inert gases and ultrafine aerosol particles) has a high inhibitory effect against combustion of organic matter in air.

The principal merits of this firefighting foam generator are:

- high fire extinguishing effectiveness;
- ecological safety (including due to the absence of the ozone-degrading effect typical of refrigerants);
- absence of a corrosive effect upon electronic and electrical engineering equipment by the generated gas-aerosol mixture;
- small size and weight characteristics (they are 8-12 times lower than for the operating devices of refrigerant fire extinguishers).

Such a firefighting foam generator is also economically effective when it is used for area suppression of fires involving sealed transformer boxes equipped with special fire-resistant metallic floors designed by the VNIIPO [not further identified] of the Russian Ministry of Internal Affairs.

When foam systems are used to suppress transformer fires in place of the water systems usually employed, the need for collecting, draining and treating the oil-containing runoff disappears, which not only produces an economic impact but also makes it possible to maintain a favorable ecological situation around the ATETs.

Creation of an automated fire safety system is foreseen in order to monitor the condition of equipment presenting a fire danger, detecting conditions making fire probable, and activating active fire protection systems at the ATETs.

The main information and controlling functions of the automated fire safety system are:

- detecting a fire in protected rooms;
- monitoring the parameters of operating conditions and the positions of the controls of the water and gas fire extinguishing units;
- checking to see that ventilation is switched off and that doors of protected rooms are closed;
- controlling the working equipment of the water fire extinguishers in "Waiting" and "Fire Suppression" modes;
- controlling detonation of pyrotechnic cartridges of foam firefighting modules and gas firefighting bottles;
- automatically connecting back-up equipment.

Implementation of the fire protection measures written into the plan for the second generation of the Bilibinskaya ATETs, including use of nonflammable or fire-resistant substances and materials, separation of buildings and structures into fire protection zones to prevent the spread of fire beyond their limits, combination of passive and active fire protection resources, and wide use of automated systems to monitor the state of materials presenting a fire danger and to control fire extinguishing systems, can ensure a high level of fire safety at the nuclear power station, which may be classified as an ATETs with heightened fire safety.

Bibliography

1. "Results of Modeling Fires at a Nuclear Power Station (Great Britain)," ATOMNAYA ENERGETIKA ZA RUBEZHOM, No 9, 1989 (Informenergo).
2. Todres, Yu. V. and Urusov, V. V., "Fire Protection of the Cabling of Safety Systems in Nuclear Power Stations," PROBLEMY BEZOPASNOSTI PRI CHREZVYCHAYNYKH SITUATSIYAKH, No 7, 1992 (VINITI).

Abstracts from 'ATOMIC ENERGY' Oct 94

957A0216A Moscow ATOMNAYA ENERGIYA in Russian No 10, Oct 94 pp 319-320

UDC 621.039.5.33 Belyayev, L.I., Voropay, N.I., Kovalev, G.F., Kononov, Yu.D., Korneyev, A.G., Lagerev, A.V., Marchenko, O.V., Medvedeva, Ye.A., Trufanov, V.V., Khanayeva, V.N., "Economic Consequences of Premature Commissioning of AESs", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 243-249.

[FBIS Translated Text] Two versions of nuclear power development are considered - continuing operation of existing AESs to the end of their service life and premature (1995-1997) decommissioning of all AESs with

RBMK-1000 and the first generation VVER-440. Calculations were performed using mathematical models of the fuel-energy complex, electric power system and foreign connections of the fuel-energy complex. The cost of construction of thermoelectric power plants to replace the AESs and additional cost of fuel, the fuel base development and delivery of fuel and electric power were determined. It has been found that the following total expenditures will be needed in 1994-2010 to execute the program of premature decommissioning of AESs: capital investment - $13-17 billion, fuel cost - $18-20 billion. Tables 5, references 9.

UDC 621.039.51 Ionov, V.S., "Reactivity and Neutron Dynamics", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 249-257

When analyzing methodological problems of three-dimensional kinetics based on results of experiments conducted on a VVER-1000 full-scale core one examined simulation of continuous distributed neutron transient processes, the role of reactivity in describing them and uncertainties related to determining reactivity values. The use of adiabatic approximation and introduction of reactivity result in multiplicative representation of the solution of the kinetics equation that contains an amplitude factor and form function, which was confirmed by experimental results.

Reactivity determined from measured neutron flux density is only representative some time after the end of disturbance and end of redistribution of the concentration of sources of delayed neutrons. Reactivity does not provide exhaustive information on the character of three- dimensional changes of neutron flux density over the duration of a transient process and is only a determining factor during the final stage of a transient process. References 5.

UDC 621.039.51 Gorodkov, S.S., "Use of Multiprocessor Computers for Neutron-Physics Analysis of Reactors", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 257-261

A valid forecast of accident-free operation of a reactor in all permissible situations can only be assured by using high-quality simulation complexes. Wide-scale use of parallel computing is a necessary condition for conducting a huge volume of real- or accelerated-time calculations during the operation of such complex. The paper describes the experience of layer-by-layer multisequencing of a three-dimensional grid of a program for analyzing neutron fields in large power reactors and implementation of the program on a desktop multitransputer computer. References 3.

UDC 621.039.534 Bagdasarov, Yu.Ye., Bogoslovskaya, G.P., Zhukov, A.V., Ivanov, Ye.F., Sorokin, A.P., Kolesnik, V.P., Ushakov, P.A., "Emergency Cooling of Fast Reactor Fuel Cell Assemblies During Boiling Under Free Convection Conditions", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 262-267

The paper presents results of experimental studies of boiling of liquid metal heat transfer agent in the circular channel of a fast reactor and in a model fuel cell assembly that occurs in emergency operating modes of the reactor core and is related to disturbance of core cooling.

The design of working zones and methods for measurement and processing of experimental data are examined. Experimental results in the form of initial graphic materials are illustrated. Works on studies of processes related to disturbance of reactor core cooling and possible subsequent core melting and breakdown are referenced.

The obtained material is aimed at developing methods for describing scenarios of development of emergency situations, obtaining quantitative characteristics of emergency processes and developing methods and hardware for reducing unwanted consequences of emergency processes. Figure 5, references 9.

UDC 621.039.536.24 Gerliga, V.A., Kozlov, A.V., Denisenko, V.Yu., "Investigation of Thermohydraulic Processes in Steam Generating Tube Bank Using Mathematical Simulation Method", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 267-271

The paper deals with studies of non-steady thermohydraulic processes in the intertube space of a horizontal tube bank that are typical for PGV-1000. A two-dimensional mathematical model of thermohydraulic processes for a steam- water mixture circulating in the intertube space is examined. Results and analysis of calculations of non-steady thermohydraulic processes in the intertube space under certain PGV-1000 operating modes are presented. Figures 2, references 6.

UDC 621.039.342 Levin, Ye.V., In Tsuntun, "Gas Centrifuge Separation of Multicomponent Isotope Mixtures - Method for Approximate Solution of System of Diffusive Transfer Equations and Analysis of Certain Separation Characteristics", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 271-279

A method for solving a system of equations of diffusive transfer of multicomponent isotope mixtures in a gas centrifuge is described. The solution is sought relative to component concentration averaged over the components concentration radius. The problem is linearized by using iterative clarification of nonlinear terms. The method makes it possible to take into account the dependence of the generalized diffusion factor on the composition of the separated mixture. Based on the method the effect of component concentration on separation coefficients and centrifuge efficiency are analyzed. It is demonstrated that increasing mean molecular mass of the mixture reduces the efficiency. Approximation formulas for calculating separation coefficients as a function of mixture composition are proposed. The formulas have the form of third degree polynomials and can be used in analysis of gas centrifuge series. Figure 1, table 1, references 11.

UDC 621.384.634.3:539.1.074.2:519.28:543.08.047:552.57 Onishchenko, A.M., "Improving Accuracy and Validity of Radiometry Systems", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 279-287

The paper deals with improving the accuracy of measurement and validity of control and classification by special selection of the most informative signal pairs. Scatterings of normally distributed stochastic signal pairs within ellipses of equal probability density are described consistently and in great detail. Dependences of the information content criterion on parameters of signal scattering ellipses and the probability of error of differentiating adjacent values of the controlled parameter on the correlation coefficient, ellipse slope and distance between the ellipses are given. Based on the above a methodology for fast elimination of low information content and selection of the most informative sets of normally distributed signals is proposed. Figures 5, references 6.

UDC 621.384.634.3:539.1.074.2:519.28:543.08.047:552.57 Onishchenko, A.M., "Improving Accuracy of Radiometry Systems by Using New Classification and Measurement Algorithms", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 287-295

The paper deals with improving the accuracy of measurement and validity of classification by using new measurement and classification algorithms for pairs of stochastically coupled correlated signals. The classification algorithms are constructed based on determination of the type of separating functions for various covariance matrices of scattering of normally distributed signals in adjacent images. The new algorithm for deriving an unknown controlled parameter automatically takes into account unequal signal scattering in the case of close values of the controlled parameter. The use of the new algorithms for classification and parameter derivation makes it possible to drastically reduce the probability of error when differentiating close classes and significantly reduce errors in parameter derivation. Figures 6, tables 1, references 3.

UDC 541.182.21.3 Kashcheyev, V.A., Mikhalkova, O.A., Poluektov, P.P., "Statistics of Electric Charging of α-Active Aerosols", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 295-299

Using the detailed equilibrium method, a system of equations has been derived that makes it possible to calculate functions of charge distribution over α- active aerosol particles on a computer. It is demonstrated that in the case of high particle activity the charge distribution is described by a normal law with the variance determined by the statistics of escape of secondary electrons from the particles. Figure 1, references 3.

UDC 539.17:621.039 Ado, Yu.M., Kryuchkov, V.P., Lebedev, V.N., "Subcritical Power Reactor Illuminated With Accelerated Protons Beam", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 300-307

The article discusses physical and economic aspects of an AES with a high current accelerator - subcritical reactor pair. A chain reaction in the subcritical reactor is induced by neutrons generated in a uranium or lead target bombarded by protons accelerated to several hundred MeV. The physical principles the power unit is based on eliminate the probability of reactivity- caused accidents which have the most tragic consequences. An attempt is made to estimate the range of acceptable values of main parameters of such power unit. Economic analysis demonstrates that it is possible to switch an AES to a subcritical reactor with the cost of electric power increasing by not more than 10 to 15 percent. Figures 8, tables 2, references 29.

UDC 541.183+621.039 Sharygin, L.M., Moiseyev, V.Ye., Muromskiy, A.Yu., Sarayev, O.M., Morozov, V.G. "Deactivation of AES Retention Ponds Heat Transfer Agent With Zirconium Phosphate Inorganic Sorbent", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 308- 313

Dynamic testing of grade Thermoxide-3A sphere-granulated zirconium phosphate sorbent was conducted on an experimental test bed with a simulator of the Beloyarsk AES retention pond water. With continuous filtration of the simulator at a rate of 20 column volumes (c.v.) per hour a 5×10^3 coefficient of deactivation of ^{137}Cs with the service life of 14,500 c.v. of water was obtained. Optimum conditions that ensure maintaining pH at a neutral level and efficient extraction of cesium and hardness salts have been determined. A cyclical charging operating mode was tested wherein as specific radioactivity of the imitator dropped down to 1-5 percent of initial radioactivity a new portion of ^{137}Cs was added and the cycle was repeated. As a result of conducting five cycles a 26,500 c.v. sorbent life was achieved, and the sorbent was still fit for service by the test end. Figures 7, references 21.

UDC 621.311.25.004.7 Borisov, S.Ye., Kudryavtseva, A.V., Leshchenko, A.V., Lukyanov, M.A., Mashkovich, V.P., Morev, M.N., Neretin, V.A., Tsofin, V.I., "VVER-500 As Source of Induced Activity During Decommissioning", ATOMNAYA ENERGIYA, 1994, Vol 77, No 4, pp 314-318

The paper presents results of two-dimensional calculations of long-lived induced activity in structures and materials of a prospective improved safety power unit with a VVER-500 water-water reactor with a 1800 MW heat output during its decommissioning. In calculations one was using software-constant complex AKTIVATSIYA-2 (KASKAD-1 software and DLC-23/CASK constants library).

Time-space distributions were calculated for main activation reactions. Total activity for individual elements and protective materials is also given. Detailed information obtained during the work is analyzed. Figures 5, references 13.

Determining Degree of Cs-137 Contamination of Territory of Lviv Oblast Localities

957A0219A Kiev EKOTEKHNOLOGII I RESURSOSBEREZHENIYE in Ukrainian
No 4 Jul-Aug 94 pp 28035

[Article by O.G. Vlokh, V.A. Grabovskyy and O.S. Dzendzelyuk (State University imeni I. Franko, Lviv) under the "Environmental Protection" rubric; first paragraph is the article summary; received Oct 12 94; UDC 546.36:614.876(477.83)]

[FBIS Translated Text] Results of spectrometry studies of Cs-137 contamination of Lviv oblast localities are presented. It was determined that the density of radioactive cesium contamination of the oblast soils is between 0.03 and 0.2 Ki/km^2. Gamma fields and contamination density maps (scale 1:1,000,000) are presented. Considerable deviations from the exponential law of vertical distribution of Cs-137, which cannot be explained by the consequences of the ChAES accident, were detected. Various sampling methods are compared regarding their effect on the adequacy of the obtained experimental results vs. actual data.

High intensity technogenic activity during the recent decades and high concentration of industrial and agricultural production accompanied by disregard for nature protection standards have resulted in exceeding permissible limits of environmental contamination. As a result the most part of Ukraine's territory is at the threshold of ecological crisis. The ecological situation has deteriorated considerably as a result of the Chernobyl catastrophe. Hence the majority of our State's population resides under ecologically unfavorable conditions which results in shorter average life expectancy, increasing level of oncological diseases, lower birth rate and disturbance of genetic processes, which threaten the very preservation of Ukraine's people genofond. At stake are safe life in contaminated areas and preventive people's health improvement in ecologically clean health resort, medicinal and recreation zones. This is why reliable information on the status of radionuclide contamination of the territory under these conditions becomes especially important when developing recommendations on people's life, health improvement, medical treatment and recreation.

Taking the above into account and per order of the Ministry of Population Protection From Consequences of the Chernobyl AES Accident the authors studied the degree of Cs-137 contamination of the territory of Lviv oblast localities.

Research Methodology. In 1991-1993 over 4000 soil samples had been taken and Cs-137 content in them was studied. The work was conducted in accordance with recommendations approved by the Ukrainian Interagency Commission on Radiation Control of Environmental Contamination [1].

Gamma spectrometry analysis of the samples was conducted according to accepted methodologies [1-3] using spectrometers assembled on the basis of spectrometry complex SU-01F. Germanium-lithium drift detectors DGDK with gamma quanta detection sensitivity of 90 and 80 mm2 for Co-60 second line with a 1332 keV energy were used as gamma radiation detectors. Energy separation of the spectrometer for gamma quanta with a 661 keV energy was 2.5 keV. External gamma radiation was shielded with 50 mm thick lead protection. The spectrum was composed in real time using a Marinelli jar (3 l capacity in 5,400 s, and 1 l capacity in 7,200 s) as a measuring bowl. For both geometries of the experiment the spectrometers were calibrated for efficiency of detection of different energy gamma quanta using standard samples made at VNDIFTRV [expansion not given] (Moscow).

Spectrometry studies were conducted using a package of application programs for processing of gamma spectra developed by NVTs [scientific production center] "Atompryladservis". The programs make it possible to automate spectrum composition and processing - detection and identification of peaks of total absorption, calculation of specific activities A_i of individual radionuclides and integral activity of a soil sample, and calculate the density of surface contamination P_i with a specific isotope. The values of A_i and P_i were calculated from the following formulas:

$$A_i = N_i/\varepsilon_i q_i tm, \quad (1)$$

where N_i is the number of gamma quanta with a certain energy detected by a spectrometer detector over spectrum composition time t; ε_i is absolute efficiency of detection of gamma quanta with a given energy when using an experiment geometry; q_i is quantum yield; and m is the mass of the sample taken for analysis; and $P_i = 2.7 \times 10^{-11} A_i M/mSn$ [Ki/km^2], (2) where M is the total mass of a sample; S is the area of the sampling device; and n is the number of pricks (individual samples).

Research Results. The Lviv oblast is located in Ukraine's Far West and has an area of 21,800 km^2. Geographically the oblast is situated at the south-western edge of the East European Plain and in the western part of the northern macroslope of the Ukrainian Carpathian [4]. Five nature regions are identified in the oblast territory: the mountainous Carpathians in the South, adjacent pre-Carpathian Ridge, Podil Ridge (Plateau) in the central part, and Male Polissya and Volyn Ridge in the North. The highest points are Mountain Pikuy (elevation 1,405 m) at the border with the Transcarpathian oblast and Mountain Kamula (elevation 471 m) in the plain part. The Dniester and Western Bug rivers start in the oblast territory; together with their tributaries and tributaries of other significant rivers they form a fairly ramified water system. Forest vegetation prevails in the Polissya and mountainous regions.

Soils in the oblast mountainous region (the western part of the Starosambir and Drogobych rayons, as well as the Turkiv and Skoliv rayons) are mostly dark brown mountain-forest crushed rock-type, and in the rest of the territory they are mixed (from podzolic in the Sambir, Drogobych and Stryy rayons to mostly black earth in the Radekhiv rayon).

There are 1947 localities in the Lviv oblast territory, including 39 cities, 37 towns and 1871 villages, with 2,686,000 residents as of January 1, 1987. During the work 556 localities, including 39 cities, 34 towns and 483 villages, had been inspected; 4,060 soil samples had been taken for gamma spectrometry analysis in order to determine the degree of Cs-137 contamination. When choosing a locality for sample taking one was considering the possibility of as uniform as possible coverage of the entire oblast territory. Sampling spots at specific localities covered uniformly the entire territory of the locality.

Based on the results of gamma background measurements and studies of Cs-137 content the following maps (scale 1:1,000,000) were plotted: power of the gamma radiation exposition dose (Figure 1) and Cs-137 contamination density (Figure 2).

Analysis of the obtained data demonstrates that mean values of power of the gamma radiation exposition dose in the Lviv oblast territory vary within a 6- 14 μR/hour range, which does not exceed permissible sanitary norm levels. For individual localities maximum values of the dose vary between 15 and 20 μR/hour. This is typical for large population centers (the city of Lviv - 18, the town of Velykyy Lyubin - 20 μR/hour) and some villages (the village of Staryy Kropyvnyk, Drogobych rayon - 16, the village of Lany, Peremyshlyany rayon - 15 μR/hour).

Such spread of dose power values can probably be due to differences in the content of natural radionuclides (especially potassium-40) in various soil types and to technogenic activity [5, 6]. Spectrum analysis of the samples demonstrates that the contribution of natural potassium-40 to the overall activity of a studied sample and accordingly to power of the exposition dose is considerably higher than the contribution of other radionuclides and can reach 60 to 80%.

The typical mean value of power of the exposition dose for the most part of the Lviv oblast territory (see Figure 1) is 6-10μR/hour. The north-eastern lowland part of the oblast (the Radekhiv, Brody, Zolochiv and part of Sokal rayons) has the lowest values of background gamma radiation.

It has not been possible to detect definite dependence between the character of the terrain and power of the exposition dose. One can only state that in mountainous regions of the oblast the pattern of background gamma fields is more spotty compared to the lowland part. The most likely explanation of this fact is low, compared to natural potassium-40, contribution of uranium and thorium radioactive series to formation of background gamma radiation of the terrain, as their content in mountain rock is higher than in plain landscape soils, and insignificant amount of relatively short-lived isotopes, generated by man's technogenic activity, in the soils.

Results of gamma spectrometry analysis of the soil samples (see Figure 2) demonstrate insignificant (between 0.03 and 0.2 Ki/km^2, which is within accepted tolerances) Cs-137 contamination of the territory of Lviv oblast localities. At the same time one observed considerable non-uniformity of distribution of cesium content in soils in the oblast territory, as well as in individual rayons. There are localities where the level of Cs-137 contamination is several times higher than the rayon and oblast averages (for instance, the town of Rudky, Sambir rayon, town of Pidbuzh, Drogobych rayon, etc.) In addition, higher than in adjacent rural territories contamination was noticed in large population centers with well developed industry. A similar relationship was also noticed during radiological studies of Poland's territory [5, 6].

One can also state that the spread of values of surface contamination of soils with Chernobyl origin radionuclides and consequently the value of power of the exposition dose are substantially affected by a combination of geological, geomorhological, climate and physical factors, such as soil type, prevailing wind direction and force, water regime and character of vegetation for each specific locality.

Availability of spectrometer calibration for two geometries made it possible to conduct efficient internal control of the quality of the obtained results by not only taking repeated measurements of samples within one experiment geometry, but also with different geometries and using different spectrometers. Results of such verifications indicate good reproducibility of the results which makes it possible to talk about the degree of trustworthiness of the obtained data. Another criterion of trustworthiness of the obtained data comparing them (Figure 3) to results of similar studies [5- 7] conducted by scientists of Polish M. Sklodowska-Curie University (the city of Lublin) in the Polish territory immediately adjacent to the Lviv oblast. When making the comparison one should keep in mind certain differences in the sampling methodologies and presentation of obtained results. Thus, in accordance with the IAEA requirements that the Polish scientists had followed, a sample is taken from a 10 cm thick surface layer of soil [8], and results are presented in terms of Bq/m^2. The authors, in accordance with Minchornobyl recommendations [1], were taking samples at localities from a 20 cm thick surface layer, and contamination density was presented in terms of Ki/km^2.

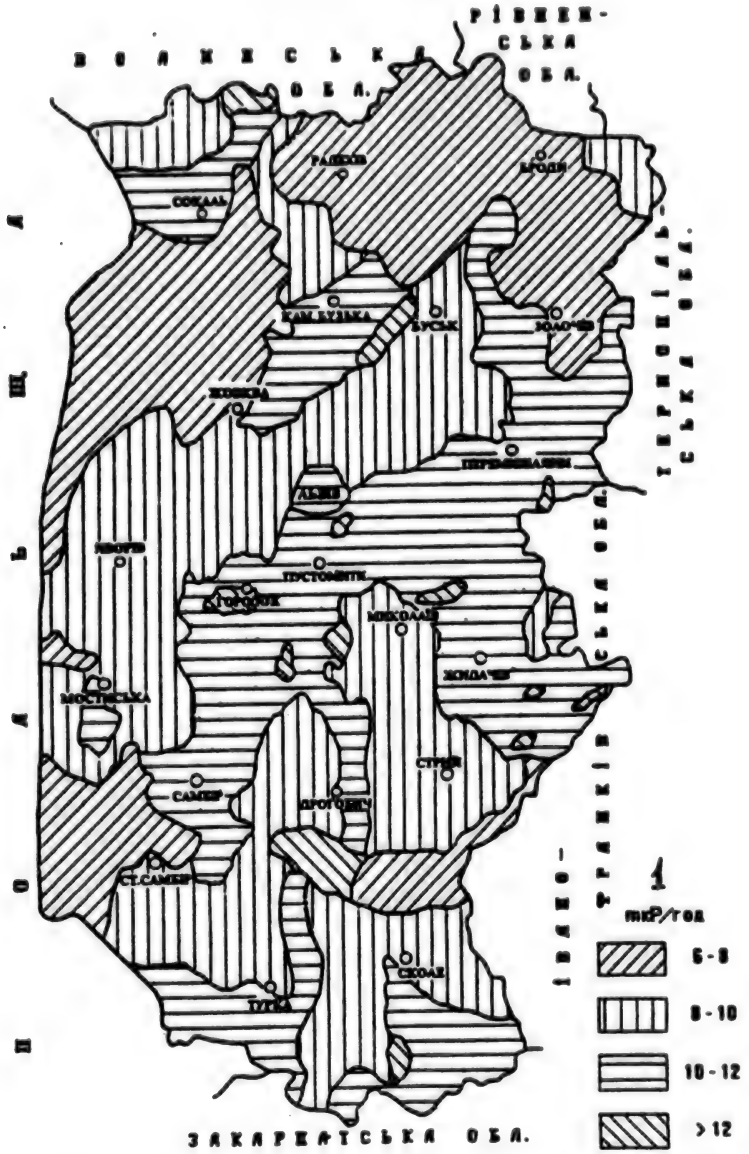


Figure 1. Power of Gamma Radiation Exposition Dose in Lviv Oblast Territory Map (Scale 1:1,000,000)

Key: 1. μR/hour

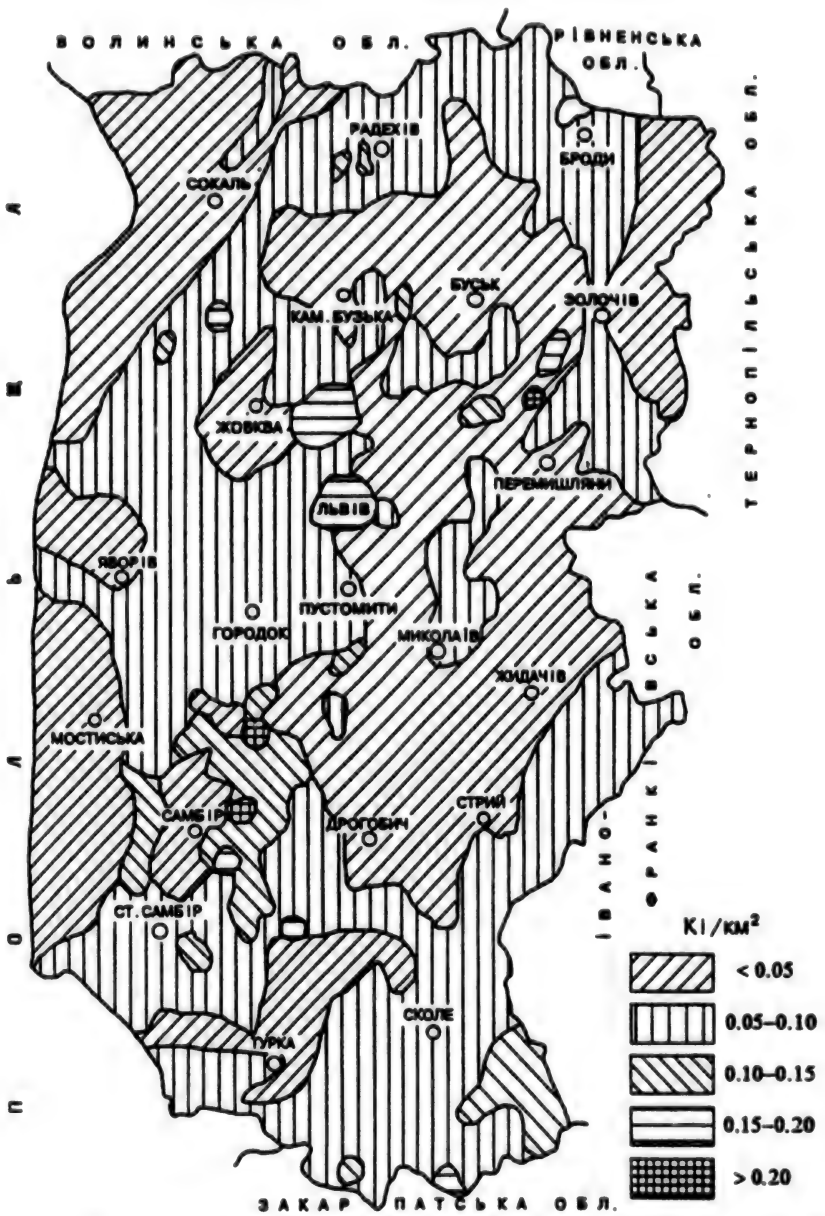


Figure 2. Cs-137 Contamination Density of Lviv Oblast Territory Map (Scale 1:1,000,000)
Key: 1. μR/hour

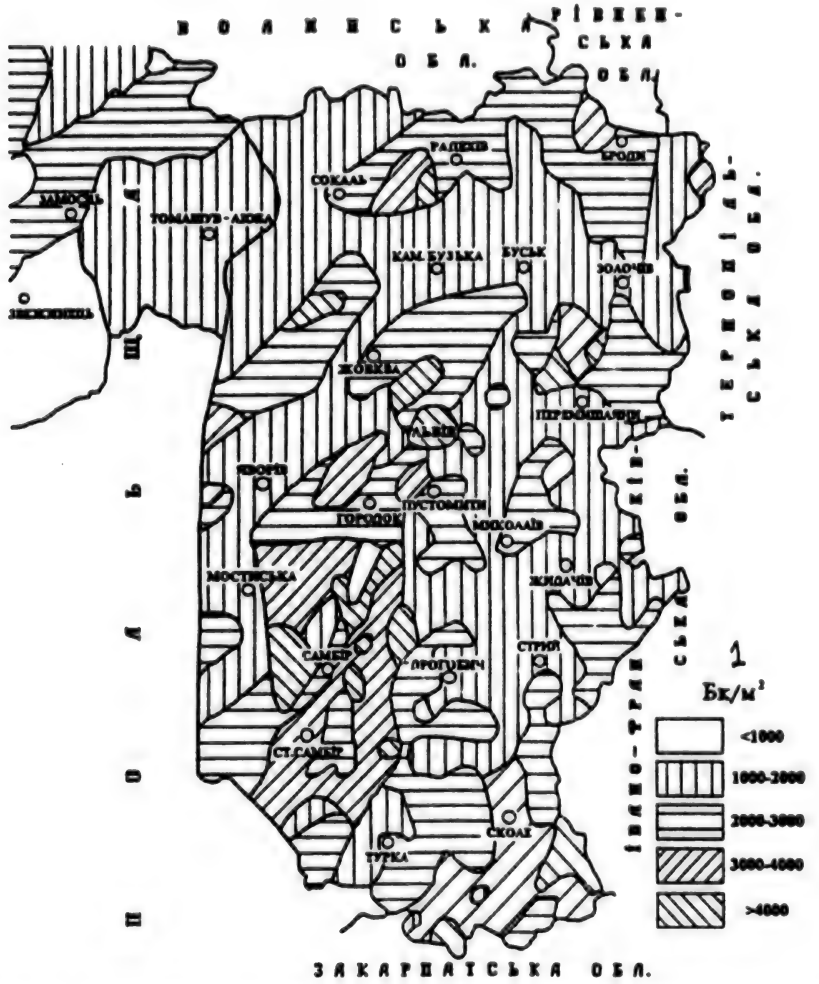


Figure 3. Cs-137 Contamination Density of Lviv Oblast and Adjacent Poland's Territory Map [5-7]

Key: 1. Bq/m^2

In order to study Cs-137 migration in soils and compare results of studies that used different sampling methodologies studies of vertical distribution of Cs-137 content to the depth of 50 cm were conducted in places with higher contamination (Figure 4). On curve 1 Cs-137 content changes according to the exponential law, which is in good agreement with data in [9-11]. Experimental results can be extrapolated by the following curve:

$$y = A \exp(-B\xi),$$

(3) where A = 165q5, and B = 0.305.

The results demonstrate that up to 90% of Cs-137 stock is concentrated within the 10 cm depth. Based on this one can conclude that with this character of vertical distribution of Cs-137 the use of both above mentioned methodologies does not introduce significant discrepancies into the results of studies of soils contaminated with Cs-137. However, soil sampling from a surface layer to the depth of 20 cm provides a more realistic contamination picture than sampling to the depth of 10 cm. Reconnaissance studies of cesium migration in other types of soils that had been conducted demonstrated considerable deviation from the exponential law (curve 2, Figure 4).

Up to the 18 cm depth exponent (2), where A = 60 and B = 0.150, provides a good description of Cs-137 distribution. However, as the depth increases further one observes a significant increase of cesium content, which reaches the maximum at the depth of around 30 cm. And the value in the peak center exceeds one-half of cesium content in the surface soil layer. The observed deviation from the exponential law of distribution cannot be explained by consequences of the ChAES accident alone. If one takes into account the rate of Cs-137 migration in

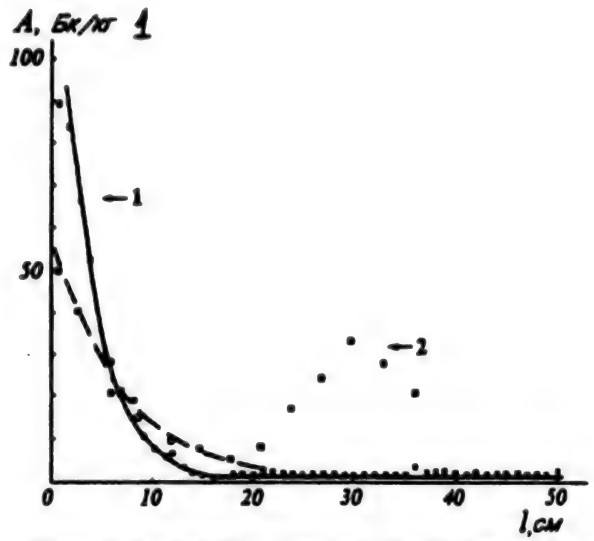


Figure 4. Vertical Distribution of Cs-137 Content in Soils: 1 - village of Zashkiv, Zhovkiv rayon; 2 - town of Rudky, Sambir rayon.

Key: 1. Bq/kg

various types of soils (on the order of 1-2 cm/year [9]) and the depth of location of the additional maximum in the observed distribution, one can assume that the maximum is due to global contamination of the environment caused by nuclear weapon tests in the late 50s and early 60s. If this assumption is correct, then using measurements of vertical distribution of Cs-137 it is possible to reconstruct the picture of radionuclide contamination in the 60s and separate contributions of the ChAES accident and nuclear weapon tests. In addition, taking into account such peculiarities of Cs-137 distribution will make it possible, by choosing an appropriate sampling methodology, to avoid considerable deviations of experimentally determined densities of territory contamination from actual densities.

The authors wish to thank G.Z. Dutsyak and L.V. Pelykh for technical help during the studies.

Bibliography

1. "Metodicheskiye rekomendatsii po otsenke radiatsionnoy obstanovki v naselennykh punktakh v zone radioaktivnogo zarazheniya so sredney plotnostyu do 5 Ki/kv. km tseziya-137" [Methodological Recommendations on Assessing Radiological Situation at Localities in Radiological Contamination Zone With Mean Density of Cesium-137 Up to 5 Ki/sq. km], Kiev, UMKRK, 1991, 37 pp.
2. "Instruktsii i metodicheskiye ukazaniya po otsenke radiatsionnoy obstanovki na zagryaznennoy territorii" [Instructions and Methodological Recommendations on Assessing Radiological Situation in Contaminated Territory], approved by the Interagency Commission on Radiological Control of Environment, Moscow, 1989.
3. Bregadze, Yu.I., Stepanov, E.K. and Yaryna, V.P., "Prikladnaya metrologiya ioniziruyushchego izlucheniya" [Applied Metrology of Ionizing Radiation], Moscow, Energoatomizdat, 1990, 261 pp.
4. ""Lvivska oblast. Atlas" [Lviv Oblast. Atlas], Chief Geodesy and Cartography Administration, USSR Council of Ministers, Moscow, 1989.
5. S. Chibowski, J. Solecki, R. Suprinovicz and J. Szcypa, "Badania skazen promieniotworczych emiterami gamma makroregionu Lubelskiego", PRZEGLAD GEOLOGICZNY, 1992, No 6 pp 371-373.
6. J. Szczypa, S. Chibowski, J. Solecki and R. Suprinovicz, "Studies of the Contamination of the Soils of Central-Eastern Poland With Gamma Emitters", in book "Radiation Protection Symposium, Obergurgl, Tyrol, Austria, 20-30 Apr., 1993", pp 1-6.
7. St. Chibowski, J. Solecki, R. Suprinovicz and J. Szcypa, "Radiochemical Monitoring of South-Eastern Poland - Mechanism of Accumulation of Radionuclides on the Earth Surface", ibid.
8. "Measurement of Radionuclides in Food and the Environment", in book "Technical Report, Ser. # 295", IAEA, Vienna, 1989, pp 5-27.
9. Pavlotskaya, F.V., "Migratsiya radiokativnykh produktov globalnykh vypadeniy v pochvakh" [Migration of Radioactive Products of Global Fallouts in Soils], Moscow, Atomizdat, 1974, 216 pp.
10. Kulakov, V.M., Lisin, S.K., Rodionov, Yu.R. and Shubko, V.M., "Vertical Distribution of Radionuclides in Soils", VOPROSY ATOMNOY NAUKI I TEKHNIKI. SERIYA YADERNO-FIZICHESKIKH ISSLEDOVANIY (TEORIYA I EKSPERIMENT), 1990, Vol 5 pp 140-141.
11. Silantyev, A.N., Shkuratova, I.A. and Bobovnikova, I.I., "Vertical Migration in Soil of Radionuclides That Fell Out As Result of Chernobyl AES Accident", ATOMNAYA ENERGIYA, 1989, Vol 66, No 3 pp 194-197.

Solid-State Sensors for Analyzing Liquid Media

957A0199A Moscow ROSSIYSKIY KHIMICHESKIY ZHURNAL (ZHURNAL ROSSIYSKOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDENELEV) in Russian Vol 38 No 1, Jan-Feb 94 pp 32-36

[Article by Yuriy Georgiyevich Vlasov, professor, doctor of chemical sciences, head chair of the Chemistry Department and director of the Solid-State Chemical Sensors Laboratory of the Chemistry Scientific Research Institute at St. Petersburg State University; UDC 543.08]

[FBIS Abstract] One way in which chemical sensors may be classified is to divide them into three groups based on the type of chemical particle they detect, i.e., by whether they are electron, ion, or molecule selective. Electron-sensitive sensors include electrodes sensitive to oxidation-reduction processes. Included among ion-selective sensors are glass electrodes, crystalline (mono- and polycrystalline) ion-selective electrodes, chalcogenide glass electrodes, and ion-selective field-effect transistors. Molecule-sensitive chemical sensors are sensitive to molecular products, including gases and biologically active materials. Among the various types of solid-state sensors available for analyzing liquid media, chalcogenide glass ion-selective electrodes [CGISEs], ion-selective field-effect transistors, and biosensors represent relatively new research directions. CGISEs, which are named after the material used to make their membranes, were first mentioned in a 1969 publication but were not developed extensively until the 1980s. CGISEs are sensitive to heavy metal ions and bromine, and their mechanism of operation is as follows: when a CGISE makes contact with a solution, a surface layer of constant thickness (100-200 nm) is formed on its membrane, and direct exchange of the ion being detected between the solution and membrane surface is measured. CGISEs are distinguished by their high chemical stability, long operating life, low response time, and superior selectivity (when compared with other types of sensors). CGISEs are promising solid-state sensors inasmuch as they are convenient to use in various aqueous media. At present, CGISEs are only being produced at St. Petersburg State University. The first mention of the ion-selective field-effect transistor [ISFET] was made in a 1970 publication. The ISFET is a field-effect transistor with an isolated gate. In the ISFET, the metallic gate that is widely used in field-effect transistors in microelectronics is replaced by an ion-selective membrane analogous with ion-selective electrodes. Among the ISFET's advantages over conventional ion-selective electrodes are the following: miniature size, which makes it especially convenient for biomedical research; low internal resistance; completely solid-phase implementation; low response time; low cost; ability to be mass produced; and possibility of producing miniature multisensors in a single process. ISFETs are now being produced that are capable of detecting the following ions: H^+, K^+, Na^+, Ag^+, Ca^{2+}, NH_4^+, Cu^{2+}, Ni^{2+}, Pb^{2+}, Cd^{2+}, NO_3^-, Cl^-, Br^-, and F^-. In addition, ISFET multisensors capable of detecting the following are being produced: Na and pH; K, H, Ca, and Na; K, Na, Cl, and pH; K and Ca; Na, K, Ca, and Cl; and K, Na, and pH. Biosensors are chemical sensors in which a biologically active material is used as the membrane or in which a biochemical process is implemented at the solution-membrane interface. The first biosensors were enzyme sensors and immunosensors. One big problem in creating biosensors remains that of immobilizing biologically active molecules on a solid surface. Biosensors are a convenient tool in biomedical practice, and enzyme sensors based on field-effect transistors have been developed to detect glucose, urea, penicillin, progesterone, and pesticides. Figures 4, tables 2; references 75: 9 Russian, 66 Western.

Laser Analytic Spectroscopy

957A0199B Moscow ROSSIYSKIY KHIMICHESKIY ZHURNAL (ZHURNAL ROSSIYSKOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDENELEV) in Russian Vol 38 No 1 Jan-Feb 94 pp 42-47

[Article by Vsevolod Grigoryevich Koloshnikov, candidate of physical and mathematical sciences, head of the High-Resolution Molecular Spectroscopy and Analytic Spectroscopy Laboratory, Spectroscopy Institute, Russian Academy of Sciences, and co-chairman of the Spectroscopists Association, and Yuriy Aleksandrovich Kuritsyn, candidate of physical and mathematical sciences, leading scientific associate, High-Resolution Molecular Spectroscopy and Analytic Spectroscopy Laboratory, Spectroscopy Institute, Russian Academy of Sciences; UDC 543:681.7.069.24]

[FBIS Abstract] In the 30 years that lasers have existed, the faces of modern optics and spectroscopy have changed radically. Intensive development of laser-based analysis methods is continuing at laboratories throughout the world. Three laser-based analysis methods that are particularly noteworthy are laser ionization spectroscopy, laser fluorescence analysis, and diode laser spectroscopy. In laser ionization spectroscopy [LIS], the sample undergoing analysis is placed in an atomizer, where it is transformed into a state of atomic vapor. Its atoms are then ionized by laser radiation, and the resultant ions are detected by one method or an other. LIS is characterized by extremely high sensitivity and selectivity and may be used to register single atoms in an analysis zone. LIS, which entails the use of pulsed dye lasers, can detect up to 80 percent of the elements of the periodic table. Various methods of atomizing samples are being studied. At present, the lowest LIS detection thresholds are achieved by thermal atomization in a vacuum. Publications have reported success in using LIS to detect elements in concentrations as low as the following (percent weight): Rh in an aqueous solution, 3×10^{-10}; gallium in high-purity germanium, 8×10^{-11}; and boron in high-purity germanium, 10^{-9}. Both laboratory and experimental prototype LIS

units have been created, including the LAFIS-1 photoionization spectrometer with a electrothermal atomizer (created jointly by the Spectroscopy Institute and Unique Instrument Making Central Design Office of the Russian Academy of Sciences). Laser fluorescence analysis [LFA] is used to detect both atomic and molecular components. In the area of molecular fluorescence, progress has been most significant in understanding the mechanism of formation of the spectra of complex organic molecules. Significant progress has also been made in using lasers in fluorescence methods of detecting atomic impurities in samples. The schematic of the analytic laser of an atomic-fluorescence spectrometer is virtually the same as that of a fluorescence spectrometer in which a classic light source is used for excitation. In LFA, continuous-wave lasers in LFA have made it possible to achieve detection levels as low as 10^{-1}/cm^3 for Na atoms, and pulsed lasers have made it possible to detect Pb atoms in concentrations as low as 10^3/cm^3. To date, several experimental prototypes of automated LFA spectrometers with electrothermal, gas discharge, and laser atomizers have been created. LAF has been used to detect Pb and Cd ions in the ice and snow of Antarctica (the detection threshold for Pb was reported to be 0.18 pg/ml which corresponds to an absolute detection threshold of 4 femtograms or 1 x 10^7 Pb atoms in a sample). LFA has also been used to detect trace levels of indium, gallium, and nickel in pure tin and aluminum in pure gallium with the following detection thresholds (atomic percent): 2 x 10^{-9} for Ga, 1.6 x 10^{-8} for In, 6 x 10^{-7} for Ni, and 1.8 x 10^{-7} for Al. Further progress in LFA will likely depend on further developments in laser technology and the development of new and improved atomizers. Dipole laser spectroscopy [DLS], which is based on the use of frequency-tuned dipole lasers based on solid lead-containing solutions, is another promising new direction in laser analytic spectroscopy. Dipole laser spectrometers are now being produced in Russia and abroad; however, transforming a diode laser spectrometer into an analytic unit will require further research and development. At present, the most important applications of frequency-tuned dipole lasers are in detecting atmospheric impurities and analyzing the process gases used in the semiconductor and nuclear industry. The use of frequency-tuned dipole lasers to analyze highly pure process gases used in the semiconductor industry seems especially promising. Other possible areas in which frequency-tuned dipole lasers appear promising include detection of the concentrations of toxic impurities in motor vehicles' exhaust gases and medical diagnosis based on analysis of samples of exhaled air. Further progress in dipole laser spectroscopy will require improvements in the characteristics of frequency-tuned dipole lasers (mainly, raising their operating temperature and improving the modal composition of their radiation). Laboratory prototype frequency-tuned dipole lasers based on PbEuSeTe (3-6 μm) with a binary heterostructure operating in a pulsed mode at temperatures up to 243 K and in a continuous-wave mode at temperatures up to 175 K have already been rated. Interest in lasers based on $A^{III}B^{III}$ compounds (AlGaAs, InGaAsP, etc.) that are capable of operating at room temperature with radiation in the range from 0.65 to 3 μm has also been increasing in recent years. Table 1; references 19: 11 Russian, 8 Western.

Energy Transfer and Concentration Quenching of Luminescence in Microemulsions. Computer Simulation

957A0206A Moscow KHIMICHESKAYA FIZIKA in Russian Vol 13 No 10 Oct 94 (manuscript received 8 Dec 93) pp 26-36

[Article by V.F. Razumov and A.G. Ivanchenko, Chemical Physics Institute, Russian Academy of Sciences, Chernogolovka; UDC 535.37]

[FBIS Abstract] Computer simulation based on the Monte Carlo method was used to examine concentration quenching of luminescence in microemulsions and micellar solutions. The analysis focused solely on the inductive-resonance interaction of molecules and on the concept of the formation of quenching pairs. The microemulsion system examined consisted of a large number of identical microparticles that solubilize the luminophor's molecules. The solubilized molecules were assumed to be randomly distributed close to the surface of the microemulsion particle, which in turn made it possible to assume that the micelle itself or microparticles remain unchanged during solubilization. It was further assumed that no exchange of luminophor molecules between the different micelles or microparticles occurred during the lifetime of the excited state and that there was no significant change in the relative location of the luminophor molecules within an individual microparticle. The simulation demonstrated that the experimental data present in the literature on concentration quenching of luminescence may be explained on the basis of two hypotheses. According to the first hypothesis, radiationless deactivation of the excited state occurs in extinguishing pairs whose critical formation distance may be significantly greater than the characteristic formation distances of stable dimers of dye molecules. In accordance with the second hypothesis, the likelihood of excitation reaching the extinguishing centers is greatly increased by migration of the electron excitation energy along the luminophor's molecules. On the basis of the analysis performed, it was concluded that the experimentally observed nature of concentration quenching of luminescence, which is intermediate between the static and dynamic types, is linked to the formation of quenching pairs. The static component of quenching is concluded to be due to the fact that the excitation of a quantum of light immediately after absorption reaches the quenching pair, whereas the dynamic component of quenching is said to be due to the fact that the excitation migrates along the luminophor's molecules. The question of whether the excitation finds a quenching pair or whether a quantum of light is emitted is left open. The problem preventing the formulation of a definitive conclusion is said to be that there is no known reason why

molecules located a distance of 10-30 angstroms apart form quenching pairs in which radiationless deactivation of an excited state occurs so effectively. Figures 4; tables 1; references 25: 13 Russian, 12 Western.

Velocities of Wave Disturbances Behind Shock Fronts in Porous Specimens of Aluminum

957A0206B Moscow KHIMICHESKAYA FIZIKA in Russian Vol 13 No 10 Oct 94 (manuscript received 24 Feb 94) pp 116-120

[Article by I.M. Voskoboynikov, I.K. Tolstov, and A.I. Malkin, Chemical Physics Institute imeni N.N. Semenov, Russian Academy of Sciences, Moscow; UDC 539.63]

[FBIS Abstract] The velocities of wave disturbances behind shock fronts in porous specimens of aluminum and the pressures transmitted through the aluminum specimens to liquid CCl_4 located behind them were examined in a series of experiments. Shock waves were created in the aluminum specimen by hurling a disk made of D-16 duralumin (2 mm thick x 40 mm in diameter) toward it at a velocity of 3.24 mm/μs under the force of an explosive charge. When the velocity of the approaching duralumin plate remained unchanged, the pressures at the shock front in the CCl_4 did not depend on the specimen's porosity. The velocities of the wave disturbances behind the shock fronts in specimens with densities of 2.19 to 2.53 g/cm^3 were close to the calculated space velocities of sound determined by compressibility. In the case of specimens with densities of 2.63 and 2.71 g/cm^3, on the other hand, the velocities of the wave disturbances behind the shock fronts were a factor of 1.15 times higher than the said space velocities of sound. The experiments further demonstrated that in the case of aluminum specimens with a density greater than 2.63 g/cm^3, that matter of the specimen behind a shock front has a shear strength that was absent in specimens of lesser density. Figure 1, table 1; references 7: 4 Russian, 3 Western.

Interaction of Electromagnetic Fields With Biosystems and the Dielectric Properties of Protein Solutions

957A0207A Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 3, FIZIKA ASTRONOMIYA in Russian Vol 35 No 4, Jul-Aug 94 pp 63-68

[Article by Yu.M. Petrusevich and N.V. Brilliantov; UDC 621.317]

[FBIS Abstract] The effect of electromagnetic fields on specific rotational Brownian mobility was examined in a theoretical analysis of the interaction of electromagnetic fields with biosystems and the dielectric properties of protein solutions. A theory of dielectric relaxation of systems of interaction of Brownian particles in a solution was developed that provides a simple explanation for the discrepancies existing between theoretically calculated and experimentally observed interactions. Specifically, the analysis demonstrated that the nature and degree of the discrepancy between experimental and calculated frequency dependences are determined by system parameters such as the charge and dipolar moment of Brownian particles and their concentration. The specifics of molecular motion in biopolymer solutions was shown to be linked to the anomalously high dipolar moment of the macromolecule of the charged protein, which equals 10^2-10^3 D. The rotational Brownian moment of a charged protein's macromolecule was described by a Langevin equation in which both the usual random moment of the forces exerted by the particles of solvent and the moment of forces exerted by other Brownian particles are taken into consideration. Calculations based on the proposed model demonstrated that giving consideration to the interaction of charged particles results in a significant change in the form of the solution's frequency dependences in relation to the conventional Lorentzian form. The said calculations also established that given a constant concentration of protein solution, the dependence's minimum shifts to the higher-frequency side become sharper as the charge and dipolar moment of the charged protein macromolecule increase. It was reiterated that no finalized theory of the dielectric properties of more complex molecular systems (such as the cells and tissue of living organisms) exists at the present time. Figure 1; references 8: 3 Russian, 5 Western.

Combined Effect of Optic- and Millimeter-Range Electromagnetic Radiation on the Growth of Single-Celled Animals

957A0207B Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 3 FIZIKA ASTRONOMIYA in Russian Vol 35 No 4 Jul-Aug 94 pp 68-71

[Article by T.I. Belaya, L.D. Gapochka, M.G. Gapochka, T.S. Drozhzhina, G.A. Karaush, and A.P. Sukhorukov; UDC 621.317]

[FBIS Abstract] A study examined the combined effect of laser irradiation and irradiation by extremely high frequency [EHF] electromagnetic waves on the growth of two types of single-celled organisms, namely, the green algae *Scenedesmus quadricuada* and the infusorian *Spirostoomum ambiquum*. GCh-141 and GCh-142 generators were used as millimeter-wavelength radiation sources. The specimen animals were placed in Teflon dishes that were irradiated from the bottom by metal horns at wavelengths of 4 and 5 mm for 15 and 30 minutes. The radiation power was controlled so as not to exceed 5 mW/cm^2. A Kolokolchik laser with a wavelength of 1.3 μm and power of 20 mW served as the laser radiation source. The effects of the radiation on the growth of the protozoa and algae studied were judged by the changes in their populations as compared with control populations. The size of the algae population was counted on a photoelectronic calorimeter, while that of

the protozoa population was counted in a Bogorov chamber under a binocular. At a wavelength of 5 mm and irradiation time of 15 minutes, EHF irradiation proved to be a significant stimulant of protozoa growth. At a wavelength of 4 mm for 15 minutes and at a wavelength of 5 mm for 30 minutes, however, EHF irradiation resulted in lower growth rates than were observed in the control protozoa. Laser irradiation also stimulated protozoa growth at certain wavelengths and irradiation times while inhibiting it at others. A sharp increase in infusorian growth was noted after laser irradiation for 45 seconds. The combined effect of EHF and laser irradiation (EHF irradiation at a wavelength of 5 mm for 15 minutes and laser irradiation at a wavelength of 1.3 μm for 45 seconds) was also studied. The sequence in which laser and EHF irradiation were performed was found to affect the growth of both types of single-celled animals studied and was especially important in the case of protozoa. The biggest growth-stimulating effect was achieved when EHF irradiation was performed before laser irradiation. When laser irradiation followed EHF irradiation, it either completely eliminated the inhibiting effect of EHF irradiation or else intensified its stimulating effect. Figures 4; references 2 (Russian).

Effect of EHF and Microwave Electromagnetic Radiation on Liquid Water

957A0207C Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: SERIYA 3 FIZIKA ASTRONOMIYA in Russian Vol 35 No 4 Jul-Aug 94 pp 71-76

[Article by L.D. Gapochka, M.G. Gapochka, A.F. Korolev, A.I. Kostiyenko, A.P. Sukhorukov, and I.V. Timoshkin; UDC 532.783+536]

[FBIS Abstract] A study examined nonthermal resonance effects of microwave radiation on liquid water. Spectrophotometric and nuclear magnetic resonance studies were conducted of distilled and twice-distilled liquid water that had been subjected to continuous-wave or pulsed microwave radiation with various frequencies, power levels, and other parameters. The studies established that microwave radiation does not cause changes in optical density in the range from 350 to 900 nm but does cause an increase in optical density in the near-ultraviolet range (from 350 to 190 nm). The said changes are identical for water irradiated with either high-power pulsed radiation or low-intensity continuous-wave radiation. The spectra of water irradiated with high-power (800 kW) microwave pulses were found to contain a characteristic increase in optical density when the wavelength is decreased from 300 to 225 nm (peak). Water irradiated with low-intensity (10 mW) continuous-wave radiation was also observed to undergo an increase in optical density in the near-ultraviolet range. The said increases in water's optical density in the ultraviolet region of the spectrum was linked to excitation of the water molecule's electron configuration. The experiments were thus concluded to be evidence of the fact that microwave radiation induces changes in the H_2O molecule itself. The nuclear magnetic resonance [NMR] studies of liquid water that were conducted included a comparison of the chemical shift of the proton ^1H and spin-lattice relaxation time (T_1) of irradiated specimens and those of nonirradiated (control) specimens. The chemical shift of the proton ^1H was measured with respect to an internal standard—hexamethyldioxane—on a Tesla BS-497 spectrograph. A shift of the proton peak of the irradiated specimens to the strong field relative to the control specimen was fixed in the spectra. The said microwave radiation-induced shift to the NMR signal of the proton ^1H to the strong field was said to correspond to a change in the parameters of the H bonds and an increase in the electron density on the proton of the water molecule. The said results, coupled with spectrophotometric data obtained during the study, led to the conclusion that microwave radiation results in changes in a water molecucle's electron configuration as well as in changes in the intermolecular structure of H_2O. The said changes were observed for 2-3 days, thus indicating the presence of persistent metastable states of liquid water that develop under the effect of microwaves. Figures 3, tables 3; references 4: 2 Russian, 2 Western.

Study in the Area of Obtaining High-Purity Strontium Nitrate

957A0208A Moscow VYSOKOCHISTYYE VESHCHESTVA in Russian No 6 Nov-Dec 94 (manuscript received 18 Apr 94) pp 26-34

[Article by A.A. Fakeyev, A.N. Knyazeva, A.F. Kudryashov, L.A. Leontyeva, and A.I. Sukhanovskaya, Chemical Reagents and High-Purity Chemicals Scientific Research Institute, Moscow; UDC 546.05.42;532.78,542.67]

[FBIS Abstract] A review of the scientific-technical and patent literature failed to reveal any descriptions of ways of obtaining high-purity strontium nitrate. In industry, reagent-grade strontium nitrate is obtained by crystallization from aqueous solutions. Several publications have described a method of purifying strontium nitrate by crystallization from aqueous or acidified HNO_3 solutions; however, no mention of the quality of the resultant product is made. In view of these facts, a process for purifying strontium nitrate by crystallization from aqueous solutions and coprecipitation of the impurities in a collector was studied. The following were used as starting materials: analytically pure strontium nitrate (conforming to All-Union State Standard [GOST] 5429-74), high-purity aluminum nitrate 17-3 (conforming to technical specifications) (TU 6-09-657-74), pure strontium hydroxide (TU 6-09-34-11-76), high-purity water (conforming to TU 6-09-2502-72), and chemically pure nitric acid (conforming to GOST 4461-77). Preliminary studies established the feasibility of purifying strontium nitrate by the crystallization method. Next, studies examining the process of purifying a strontium nitrate solution on hydrated aluminum oxide were performed

by way of examination of the impurities iron (III), ^{59}Fe and manganese (II), and ^{54}Mn. The studies established the necessity of painstaking removal of all particles of collector from the strontium nitrate. Deep separation of the hydrated aluminum oxide gel from the purified strontium nitrate solution was achieved by subjecting the suspension to preliminary aging and settling. The lower thickened layer of suspension was filtered twice, after which the filtered solution was subjected to boiling down and crystallization. The following process conditions were determined to be optimum: boiling temperature, 60°C; temperature of the heat transfer agent, 100°C; and flask rotation speed, 150 rpm. A 1:1 ratio of the amount of solid phase in the suspension was found to be optimum from the standpoint of removing the product from the flask without substantial loss. Removal of the strontium nitrate crystals from the mother liquor after they had been cooled and dried was performed in a combined filtration and drying device. To prevent the formation of $Sr(NO_3)_2 4H_2O$, the filtering was conducted at 35°C. A process flow was developed for obtaining high-purity anhydrous strontium nitrate containing the following concentrations of impurities (percent by mass): iron, 2×10^{-5}; vanadium, manganese, copper, nickel, and chrome, 5×10^{-6} (each); cobalt, 1×10^{-6}; and sulfates and chlorides, $< 1 \times 10^{-3}$ (each). Figures 3, tables 3; references 36: 32 Russian, 4 Western.

Modeling and Optimization of the Growth Rate and Doping Level of Epitaxial Layers of Silicon in Chloride and Hydride Processes

957A0208B Moscow VYSOKOCHISTYYE VESHCHESTVA in Russian No 6 Nov-Dec 94 (manuscript received 27 Apr 94) pp 63-76

[Article by Ye.P. Prokopyev, Materials Science Scientific Research Institute imeni A.Yu. Malinin; UDC 621.315.592]

[FBIS Abstract] A new analytical model (formula) of the growth rate [$V_p(x)$] and doping level [$N_p(x)$] of epitaxial layers of silicon has been proposed and used to demonstrate that detailed modeling and optimization of chloride and hydride processes of growing epitaxial silicon layers is possible in principle. On the basis of 21 detailed studies of mass transfer and chemical transformation in a stationary boundary layer, an expression was written that describes the growth rate of epitaxial layers of silicon in chloride and hydride processes in an approximation of the diffusion-kinetic theory of Frank-Kametskiy (1967). The model also considers the sharp increase in the growth rate of epitaxial silicon layers that occurs as the substrate's surface temperature and linear flow velocity of the vapor-and-gas mixture increase. The model includes the chemism of the surface transformation of key reagents, the different types of mass transfer of the key reagents in a stationary boundary layer, and the thermodynamics of the systems Si-H-Cl and Si-H in the stationary boundary layer range. Various process modes and the doping levels of epitaxial silicon layers were also calculated. The model was discussed from the standpoint of its use in optimizing the dependence of $V_p(x)$ and $N_p(x)$ on the parameters of processes and reactors involved in the production of epitaxial structures. Figures 6; references 34: 23 Russian, 11 Western.

Development of an Automated Data Bank Based on the Properties of the High-Purity Substances Used To Create Electronics Components for IBM PC/AT-Compatible Computers

957A0208C Moscow VYSOKOCHISTYYE VESHCHESTVA in Russian No 6 Nov-Dec 94 (manuscript received 25 Apr 94) pp 118-122

[Article by Yu.A. Denisov, Ye.Ye. Grinberg, and V.V. Avseyev, Chemical Reagents and High-Purity Chemicals Scientific Research Institute, Moscow; UDC 681.322:54-41]

[FBIS Abstract] A production frame-type data bank and expert system was developed for collecting and processing information regarding the properties of the high-purity substances used in creating electronics components. The data bank, which was created at the Inorganic Chemistry Institute of the Siberian Department of the Russian Academy of Sciences, is intended for use by specialists in the field of electronic materials science, chemist-process engineers working in the electronics industry, studies involving electronics, and chemists and others involved in the production and application of new materials with specified properties. Included in the data bank are the following: compounds' names and laboratory and industrial methods of synthesizing and purifying them; producers of reagents; structures of molecules; pressures of saturated vapors; characteristic physical, chemical, mechanical, electrical, optic, physicochemical, thermodynamic, and other properties of compounds; and various methods of identifying substances (infrared, Raman, and ultraviolet spectroscopy; nuclear magnetic resonance [NMR] and NMR-mass spectrometry; atomic absorption spectrometry; chromatography; luminescence; photoelectron spectroscopy; and various forms of x-ray spectral and x-ray crystallographic analysis). The combination data bank and expert system is interactive and menu driven and will operate in several modes, the main one being search and view. The system includes software that makes it possible to perform direct calculations with data contained in the data bank based on a built-in system of algorithms. The functions themselves are located on disk in an overlay file and are called by the shell when necessary. The system includes its own database manager that has been written in C (Microsoft) by using the CodeBase package (Sequitor Software). Data may be retrieved by the names (systematic and trivial) and formulas of compounds, by the elements and bonds present in them, and by the unique number assigned to them in the data bank. At present, the data bank and database manager are only available for IBM PC/AT-compatible computers. The possibility of creating another version for MainFrame computers and computer networks is being considered. Table 1; references 7 (Russian).

Obtaining Fuel and Nonfuel Products From Oil Shale

957A0210A Moscow ROSSIYSKIY KHIMICHESKIY ZHURNAL (ZHURNAL ROSSIYSKOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDENELEV) in Russian Vol 38 No 5 Jul-Aug 94 pp 70-74

[Article by Ye.G. Gorlov and A.B. Bol-Epshteyn, doctor of chemical sciences and senior scientific associate; UDC 662.735]

[FBIS Abstract] Scientists at the Mineral Fuels Institute have developed a series of processes for thermochemical refining of oil shale. The new processes are based on the results of studies performed in 1975-1990, which showed that the organic and mineral parts of oil shales have an activating effect on the thermal transformation of brown coals, heavy residual petroleum products, and liquid high-boiling residues of selected petrochemical processes. A process has, for example, been proposed for processing hydrocarbon raw material based on thermochemical transformation of the organic part of oil shale in a medium of hydrocarbon solvent (paste-forming agent) called thermal solvent. The thermal dissolution of oil shale is implemented at a temperature of 390-440°C under a pressure of 3-5 MPa at a space velocity of 3-6 h^{-1} in a medium of distillate paste-forming agent that boils at temperatures in the 200-340°C range. The process is directed toward production of ash (mineralized) and ash-free high-boiling products with a boiling point above 335°C. The process results in binders that meet the quality requirements specified in the All-Union State Standard [GOST] 22245-91 and may be used to produce quality hot asphalt concretes. Another version of the thermal dissolution process calls for processing oil shale together with brown coal for the Kansk-Achinsk Basin without any specially added hydrogen-donor paste-forming agent or hydrogen gas. The process, which is conducted in a 3-l-capacity reactor under a pressure of 5.0 MPa at a temperature of 410-430°C and which may be intensified by adding a catalyst system consisting of finely dispersed solid particles of slag from the enrichment of polymetallic ore, results in a binder that meets GOST specifications for oil asphalt and that may be used in road construction. One serious drawback of the new thermal dissolution process is a shortage of regenerated paste-forming agent that reaches 76 percent. Two groups of ways of remedying the problem are being explored. The first is based on engineering solutions that make would it possible to add up to 35-45 percent (weight) oil shale to the process. The said process would be used primarily to produce binders designed to replace oil asphalts, and studies are being conducted to refine a process of thermal dissolution of oil shale and mixtures thereof with Kansk-Achinsk coal in a medium of combined paste-forming agent (a regenerated distillate fraction with a boiling point of 200-335°C) and asphalt flux. A four-cycle version of the process in which Baltic shale is subjected to thermal dissolution is also being studied and refined. Besides developing processes in which asphalt flux is used as an additional component of the paste-forming agent, scientists are working on processes in which various wastes generated in the petrochemical industry (phenol and pyrolysis resins, cracking residues, and oil sludges), spent oils, and heavy coal-tar products formed in the by-product coking process are used as a component of the paste-forming agent and in which various chemical products (phenols, pyridine, individual aromatic hydrocarbons) and raw materials used to produce commercial-grade carbon, sands, electrode coke, etc., are used as binders. The proposed version of the process of thermal dissolution of oil shale in a medium of recirculating paste-forming agent and asphalt makes it possible to produce not just organic binder for road construction but also gasoline and diesel fractions that may be used as motor fuels after subsequent hydrorefining. Research on thermal transformations of asphalt flux in the presence of oil shale has made it possible to develop a process of their combined thermal cracking at 400-440°C under 3-10 MPa of pressure in an inert medium or in a hydrogen medium with a space velocity of 1-2 h^{-1}. The said process is recommended for use in processing feedstock containing oil shale in amounts of 8 to 35 percent (weight) to produce motor fuels, fuel for power generation facilities, and chemical raw materials, as well as heavy petroleums and residual petroleum products. The process offers the following important advantages: absence of special stages in which the heavy petroleum raw material is deasphaltized or demetallized; possibility of conducting thermal cracking without hydrogen and thermal hydrocracking without the use of expensive catalysts and at a relatively low pressure (3-5 MPa); and significant desulfurization of the raw material (by 40-50 percent). Figures 2, tables 6; references 14: 13 Russian, 1 Western.

Conception of a Process of Combined Burning and Gasification of Low-Grade Coal and Shaft Methane in a Fluidized Bed

957A0210B Moscow ROSSIYSKIY KHIMICHESKIY ZHURNAL (ZHURNAL ROSSIYSKOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDENELEV) in Russian Vol 38 No 5 Jul-Aug 94 pp 75-79

[Article by Albert Aleksandrovich Belyayev, candidate of technical science and senior scientific associate, head of Solid Fuels Combustion and Gasification Processes Laboratory, Mineral Fuels Institute; Anatoliy Petrovich Kondratenko, candidate of technical science and senior scientific associate, Mineral Fuels Institute; and Igor Vladimirovich Radovitskiy, candidate of technical science and senior scientific associate, sector head, Mineral Fuels Institute; UDC 662.62+662.8]

[FBIS Abstract] A process for combined combustion and gasification of low-grade coal and mine shaft methane in a fluidized bed has been conceived at the Mineral Fuels Institute. The proposed process is based on the following principles and practical recommendations: combine the functions of the supporting gas distributor and pneumatic separator to remove heavy particles (pyrite, rock, etc.) from the fuel particles throughout the entire area of the grating by sloping it at a 6-8° angle to the site where the heavy particles are unloaded; fashion the upper part of the grating body without any visible convexities or recesses; unload the heavy particles through an aerodynamic gate in the form of a discharge tub with an inner diameter 4-5 times larger than the maximum particle diameter; feed the blast into the discharge pipe in a direction perpendicular to its axis to prevent the loss of small fuel particles and ash deposited on the tube's inner service ant maintain an airflow velocity in the discharge tube of at least 12-15 m/s; equip the gas distributor with overflow tubes to unload the excess ashed particles; equip the device with a unit for process and emergency cooling of the material constituting the fluidized bed by a water-limestone mixture or by process water so as to eliminate slag formation or binding of sulfur compounds; have the aerodynamic gate operate in a pulsing regimen with a pulse frequency of 1-2 Hz; conduct the flame processes used to burn and gasify the coal in a layer of inert material (limestone, dolomite, mixtures of the two, etc.) to facilitate binding of the sulfur in the fuel, make it easier to control the temperature of the layer, and prevent piercing of the grating; have the maximum diameter of the fuel particles being processed be 2-3 times larger than the opening of the gas distributor's lattice so as to keep the particles from going through the gas distributor's holes when the process is halted; and maintain an average blasting velocity in the grating holes of at least 10 m/s so as to guarantee safe operation of the device with methane-air blowing. A schematic of a proposed flame device with a fluidized bed for use in conducting the process was developed. Use of mine shaft methane in the fluidized bed process as a way of reducing the sulfur compounds released with stack gases was deemed to be possible in principle and was said to entail using the methane to reduce sulfur dioxide to elemental sulfur that could then be extracted in its liquid state. A preliminary analysis of the proposed sulfur extraction process was performed. It was concluded that even when sulfur is present in fuel in concentrations as high as 100 g per kg fuel equivalent, condensation of approximately 96 percent of the sulfur at 140°C is definitely possible. Further theoretical and experimental research in the said direction was recommended. Figures 3; references 6 (Russian).

Prerequisites for Setting Up Mineral Wax Production in Russia

957A0210C Moscow ROSSIYSKIY KHIMICHESKIY ZHURNAL (ZHURNAL ROSSIYSKOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDENELEV) in Russian Vol 38 No 5 Jul-Aug 94 pp 80-82

[Article by G.S. Golovin; Ye.V. Zyryanova, head of Production Planning Department, Mineral Fuels Institute; A.M. Gyulmaliyev; Vadim Vitalyevich Rode, candidate of chemical sciences, senior scientific associate, and laboratory head, Mineral Fuels Institute; and Yevgeniy Mikhaylovich Novakovskiy, candidate of technical sciences, senior scientific associated, and laboratory head, Tula Detergents and Ecology Scientific Research Institute; UDC 541.132.2+541.13.4]

[FBIS Abstract] Raw mineral wax (montan wax or bitumen A) is bitumen extracted from bitumen-bearing brown coal by organic solvents (benzine, benzene, etc.). Mineral wax and its modifications obtained from brown coal have a number of unique properties that make them irreplaceable in precision lost-wax casting in metallurgy and in a number of processes in the chemical and petrochemical industries. At present, Germany produces approximately 90 percent of all mineral wax produced throughout the world (up to 50,000 metric tons annually). In the former Soviet Union, only one small plant located in Ukraine produced small volumes of mineral wax (less than 2,000 metric tons annually based on the old German process). No mineral wax is produced in Russia at the present time. A number of issues must be resolved before mineral wax production can be set up in Russia. The bitumen-bearing coal of the Yuzhniy Ural Basin is very interesting from the standpoint of a source of bitumen. Total brown coal reserves of the Tyulganskoye deposit in the Yuzhniy Ural Basin are estimated at 258.5 million metric tons. Studies conducted in the 1950s established the following bitumen yields for the said coals: 24.4-26.0 percent (in an alcohol-benzene mixture); 17.1-18.5 percent (in dichloroethane); 14.0-16.0 percent (in benzene); and 9.5-10.5 percent (in benzine). Detailed studies performed by the Mineral Fuels Institute in the late 1970s established that the coal of the Tyulganskoye deposit has an average bitumen content of 4.8 to 9.1 percent, with the resin level in the said bitumen ranging from 40 to 58 percent. A study in which Yuhniy Ural coal was used to produce mineral wax under industrial conditions resulted in bitumen with a 10-percent yield (in benzine) and 26-percent yield (in alcohol-benzene), with respective resin levels of 43 and 56.3 percent. The coal of the Khabarovskoye deposit (also in the Yuzhniy Ural Basin) also appears very promising as a source of bitumen for producing mineral

wax. The Far Eastern area of Russia also contains large bitumen-bearing brown coal reserves; however, the brown coal of the Yuzhniy Ural Basin is most promising from the standpoint of setting up commercial production. Perhaps the biggest barrier to establishing mineral wax production in Russia is the lack of equipment for implementing the process. Laboratory studies have established that wax extraction is most efficient in a device with intensive mixing of phases, such as a horizontal extractor. Analysis of the hydrodynamic conditions of extracting raw wax from brown coal in such an extractor has resulted in a prototype unit wax extraction that has since been tested with coal from the Dnepr Basin in Ukraine and the Tyulganskoye deposit in the Yuzhniy Ural Basin. The Tyulganskoye coal used had a bitumen content of 6.3-8.5 percent, an initial moisture content of 57-58 percent, and a moisture content of 18-20 percent after drying. Tests of the prototype unit with the Tyulganskoye coal established that the process works best with coal particles having a grain size of 0.2-2.5 mm, a coal-benzine ratio between 1:5 and 1:6, and an extraction time of 15-20 minutes. Test runs of the process resulted in wax yields of 78-82 percent. The raw wax obtained from the Tyulganskoye coal was higher in quality than that obtained from the Ukrainian coal. It has had a higher resin content (43 percent) than the Ukrainian coal, and its drop point (77-80°C) was 4-6°C lower than that of the Ukrainian coal. The fact that it it melted completely with paraffin was taken as an indication of its low asphaltene content. It thus appears that establishing production of mineral wax in Russia is indeed feasible. References 22: 20 Russian, 2 Western.

Chemico-technological Principles of Producing Carbon Sorbents From Caked Coals

957A0210D Moscow ROSSIYSKIY KHIMICHESKIY ZHURNAL (ZHURNAL ROSSIYSKOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDENELEV) in Russian Vol 38 No 5 Jul-Aug 94 pp 82-86

[Article by Sofya Ivanovna Surinova, candidate of technical sciences, senior scientific associate, and laboratory head, Mineral Fuels Institute; UDC 552.57.661.83]

[FBIS Abstract] A fundamentally new and more economically advantageous method of producing spherical carbon adsorbents based on caked coals has been developed at the Mineral Fuels Institute. The new method differs from existing methods used in Russia and abroad in two ways: First, binders are completely eliminated from the process, which simplifies the process flow, improves labor conditions, and significantly reduces the cost of producing the adsorbents. Second, the adsorbent granules are sphere-shaped, which is preferable from a use standpoint. The new adsorbents are characterized by superior mechanical strength (≥85 percent based on an Mis-8) and granule density (>0.5 g/cm^3). The main stages in the process for producing the new sorbents are pulverizing the coal to a particle size of less than 100 μm, granulation, drying, carbonization, and vapor-gas activation. The coal used in the process must have a suitable caking capacity and ash content (<10 percent) and must be able to be pulverized in water. Carbonization is one of the most important stages of the process because it is the state that dictates the strength and porosity of the carbonized material. The carbonization process has been demonstrated to be most effective when the carbonization temperature is approximately 700°C and when a heating rate of 15-20°C/min is used. Coal granules with a bulk density of 0.58 to 0.62 cm^3/g have been found to result in adsorbent of maximum mechanical strength (99 percent) and minimum pore volume (0.20-0.25 cm^3/g). Coal particles with a coordination number of 12 have been found to result in the highest-density adsorbent granules. When the coal is pulverized until more than 90 percent of the coal particles are less than 50 μm in size, the specific surface of the coal powder ranges from 6,800 to 7,900 cm^2/g. The spherical sorbents obtained by the new Mineral Fuels Institute process may be used for a number of purposes: adsorbents from the <1-mm fraction may be used to remove organic impurities from the wastewaters of various production processes, and the larger fractions may be used to recover solvent vapors and neutralize and concentrate various industrial offgases. The spherical adsorbents are also suitable for extracting noble metals from solutions and ore pulp. Scientists at the Mineral Fuels Institute have also developed a process for regulating the adsorbents' physicochemical and sorption properties in the final stage of their production by modifying them with different chemicals. Acid-modified adsorbent has, for example, been shown to posses high adsorption activity with respect to compounds of chromium (VI) (up to 20 weight percent depending on the starting concentration of compound in the solution). Modification of materials' chemical properties by using high-molecular weight substances has proved especially promising and has made it possible to produce carbon molecular sieves suitable for separating gaseous mixtures, including air, to produce nitrogen in the required concentration. The said carbon molecular sieves may be used in short-cycle heatless adsorption units to obtain nitrogen of the required concentration. Another promising direction of using the processes developed at the Mineral Fuels Institute for modifying carbonized caked coals is that of creating adsorbents to trap highly toxic heavy metals and radionuclides from water and biologic media. Figures 5, tables 6; references 9 (Russian).

Fuel-Containing Wastes From Coal Recovery and Enrichment as a Raw Material for the Production of Building Materials

957A0210E Moscow ROSSIYSKIY KHIMICHESKIY ZHURNAL (ZHURNAL ROSSIYSKOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDENELEV) in Russian Vol 38 No 5 Jul-Aug 94 pp 86-91

[Article by M.Ya. Shpirt, L.A. Zekel, and I.Kh. Volodarskiy; UDC 622.33.004.8]

[FBIS Abstract] For each metric ton of coal that is recovered, approximately 4 metric tons of waste rock from mine shafts and 0.25 metric tons of overburden rock are generated. In addition, when coal wastes are enriched, between 0.15 and 0.35 metric tons of waste is produced per metric ton of enriched coal. As increasingly lower grades of coal are mined, the amounts of such waste rock generated will continue to increase. In cooperation with other scientific research, design, and production organizations, scientists at the Mineral Fuels Institute have studied the mineral content of the rock generated during recovery and enrichment processes at the following coal basins: Posmoskovnyy, Donets (Rostov Oblast), Chelyabinsk, Pechora, Kuznetsk, Minusinsk, Irkutsk, Sakhalina, Neryungrinskoye, and Slantsy (Leningrad Oblast). The amounts of minerals and natural radionuclides present in the various rocks were analyzed. On the basis of their analyses, the scientists concluded that of the 30-40 million tons of coal enrichment wastes generated annually at enterprises throughout Russia, more than 60-70 percent could be used effectively in the production of building materials and thereby reduce the amount of clayey materials conventionally used to manufacture building materials and conserve 2-2.5 million metric tons of fuel each year. Only 1 of the 35 of Russia's 70 operating ore enrichment plants studied was found to be generating waste rock that could not be used in materials for residential building construction because of its high radionuclide content. In addition to analyzing the waste rock itself, scientists also conducted tests on ceramic products, porous fillers or lightweight concretes, and fused materials that several organizations, including the Mineral Fuels Institute, have produced from the fuel-containing waste from the coal recovery and enrichment process and that contain the said rock in amounts of 40 to 100 percent. The tests confirmed that although bricks and other ceramic products produced from the fuel-containing rock require additional crushing and pulverization that is not required when analogous clay-based products are produced, their manufacture requires only 60-80 percent of the fuel required in the process of producing clay-based products. Preliminary recommendations regarding using fuel-containing rock from the following coal basins were formulated: Podmoskovskiy, Donets, Chelyabinsk, Pechora, and Kuznetsk. Various fractions of the rock from the various basins were recommended for use in brick, crushed stone, and ceramic wall materials, and as additives in concrete. Tables 4; references 5 (Russian).

Carbonaceous Rock—Alternative Raw Material for Producing Heat-Resistant Nitride Ceramic

957A0210F Moscow ROSSIYSKIY KHIMICHESKIY ZHURNAL (ZHURNAL ROSSIYSKOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDENELEV) in Russian Vol 38 No 5 Jul-Aug 94 pp 91-96

[Article by Lyudmila Alekseyevna Kost, candidate of technical sciences and scientific secretary, Mineral Fuels Institute; Larisa Nikolayevna Lebedeva, candidate of chemical sciences and senior scientific associate, Mineral Fuels Institute; and M.Ya. Shpirt; UDC 662,74:661.55]

[FBIS Abstract] In Russia alone, more than 1 billion metric tons of solid carbon-containing wastes from coal recovery and enrichment processes are generated each year. Studies conducted by the Mineral Fuels Institute in collaboration with other organizations have demonstrated that these carbon-containing wastes may be used either as the basis or sole component of a feedstock for producing silicon carbide materials, silicon-aluminum alloys, thermobauxite, silicon nitride, and silicon nitride-based compounds called sialones. Studies conducted both in Russia and abroad have demonstrated that silicon nitrides, aluminum, and sialones may be used to create ceramic materials and products that retain their strength at temperatures above 1,500 K, resist erosion and heat, withstand corrosive media, have low coefficients of thermal linear expansion, and remain stable in a neutron flow. In view of these facts, a study assessed the possibility of using carbonaceous rock to produce commercial-grade nitride ceramic. The theoretical feasibility of such a process was calculated by two methods. The first method, which was a method developed for closed systems, make it possible to determine the transformations occurring in a carbonaceous rock upon heating and the makeup of its decomposition products at different temperatures. In the second method, consideration is given to the changes occurring in a system of products formed from a feedstock of carbonaceous rock as various components are removed from the system. In addition, samples of carbonaceous rock were subjected to heat treatment at 1,673-1,723 K in a nitrogen flow for 2-6 hours. X-ray phase analysis of the resultant products on a DRON-2.0 diffractometer established that carbonaceous rock with a primarily kaolinite or kaolinite-hydromicaceous makeup may be used to produce nitride-containing products of different compositions. More detailed studies of products with a primarily β-sialone composition confirmed that they may be used to manufacture commercial-grade ceramics. A process flow for obtaining sialone-containing products from carbonaceous rock in two stages (preparation of the feedstock and nitridation) was developed. Further experiments established that carbonaceous rock containing the following in their ash are suitable for producing sialone (weight percent): SiO_2, 60-65; Al_2O_3, 28-38; and Fe_2O_3 + MgO + CaO, ≤ 5 (when CaO $<$ 2). The

proposed process was tested on carbonaceous rock pulverized to a grain size of 0.25-0.5 mm. The carbonaceous rock was mixed with similarly pulverized agloporite in a ratio sufficient to give the feedstock an ash content of 65-68 percent. Because the carbonaceous rock had an iron content of approximately 3 percent, it could be processed into sialone without the addition of caking additive. Granules measuring 3-7 mm in size were manufactured from the mixture without binder. The nitriding process was implemented at 1673-1723 K, with the temperature of the mixture held constant for 2-6 hours. During the course of the process, nitrogen was blown through the feedstock at a rate of 2-2.5 l/min per kilogram of feedstock. After the nitriding, the granules had a blue-gray color and a bound nitrogen content of about 25 percent. X-ray phase analysis and infrared studies confirmed that the nitriding resulted in a product consisting mainly of β'-sialone: $Si_{3.60}Al_{2.40}O_{2.40}N_{5.60}$. Ceramics made from the carbonaceous waste rock proved to possess high erosion resistance and withstood heating in a plasma flow from room temperature to 2,273 K without cracking or blistering. The experiments thus confirmed the possibility of manufacturing heat-resistant ceramic from carbonaceous rock without adding additional caking activators. Figures 2, tables 6; references 20: 13 Russian, 7 Western.

Problem of the Complex Use of Coal and Overburden Rock: Ways of Solving It for Irkutsk Basin and Deposits of Transbaykalia

957A0210G Moscow ROSSIYSKIY KHIMICHESKIY ZHURNAL (ZHURNAL ROSSIYSKOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDENELEV) in Russian Vol 38 No 5 Jul-Aug 94 pp 97-99

[Article by G.B. Skripchenko, Ivan Mikhaylovich Shchadov, candidate of technical sciences, professor, and general director Vostsibugol Joint-Stock Company, M.Ya. Shpirt, Ivan Petrovich Krapchin, doctor of economic sciences, professor, and head of the Technical and Economic Research Laboratory, Mineral Fuels Institute; and R.Ya. Kleyman; UDC 662.333:542.1]

[FBIS Abstract] The coal deposits of the Irkutsk Basin and Transbaykalia, which serve as the raw material base of the Vostsibugol Joint-Stock Company, have already yielded 33,453,000 metric tons of coal, which makes them one of the largest coal recovery complexes in the Russian Federation. Because the deposits of the Irkutsk Basin and Transbaykalia deposits are located at relatively shallow depths in rather thick seams, they are especially well suited to strip mining. The coal present in the region is characterized primarily by low and medium stages of metamorphisms, humic and sapropelite, and as having a high moisture content (25-39 percent) and widely ranging ash content (7-25 percent). Even within the confines of a single deposit, the coal's petrographic composition is extremely varied. Eight deposits with unique sapropelite coal consisting primarily of an organic component in the form of aliphatic compounds have also been found in the region. The sulfur levels of the region's coal ranges from 0.4 (brown coal) to 8-10 percent (bituminous coal). The strip mining activities that predominate in the region result in large quantities of overburden rock with high silica and medium ash content as follows (percent): SiO_2, 40-65; Al_2O_3, 15-30; Fe_2O_3, 3-15; CaO, 2-10; and MgO, 1-2. A study examined the possibility of complex processing of the region's coal and overburden rock so as to use them to the fullest possible extent. The chemical potential of the area's coal deposits were concluded to make them suitable not only as fuel for power generation facilities and homes but as as a raw material for producing valuable chemical products and binders (bitumen) for road and civil construction. It was further concluded that the consumer value of the coal of several of the region's deposits can be increased significantly by thermochemical and thermomechanical refining. Specifically, the coal of the Tugnuyskoye, Vostochnoye, and Azeyskoye deposits was recommended for producing fuel briquettes with no binder to be used in home heating. The toxic/potentially toxic trace element and radionuclide levels of the region's coal were found to be within acceptable limits. Tables 2; references 9 (Russian).

Intensified Processing of Coal and Heavy Petroleum Residues

957A0210H Moscow ROSSIYSKIY KHIMICHESKIY ZHURNAL (ZHURNAL ROSSIYSKOGO KHIMICHESKOGO OBSHCHESTVA IM. D.I. MENDENELEV) in Russian Vol 38 No 5 Jul-Aug 94 pp 100-104

[Article by A.A. Krichko, A.S. Maloletnev, and Salambek Naibovich Khadzhiyev, corresponding member of the Russian Academy of Sciences, doctor of technical sciences, and director of the Groznyy Scientific Research Institute; UDC 662.74:552]

[FBIS Abstract] Russia's oil refining industry does not presently have any economically effective processes for deep (complete) processing of high-boiling petroleum residues into distillate products. Those industrial processes that have been assimilated in Russia for coking petroleum residues offer only a partial solution to the problem of processing petroleum more fully and, for a number of factors, cannot be used on a wide scale. A process for hydrogenation refining (hydrorefining) of bitumen at a low hydrogen pressure (6-7 MPa) that was jointly developed by the Mineral Fuels Institute, Groznyy Petroleum Refining Scientific Research Institute, Grozgiproneftekhim Design Institute, and ST-5 Pilot Production Plant may be used to more completely refine bitumen into distillate products and achieve a 90-percent depth of oil refining. The hydrogenation refining process is based on a new, highly efficient catalytic system that is in turn based on salts of molybenum, nickel, and other metals and that is formed directly in the reaction mass as a mixture of bitumen and

hydrogen-containing gas is heated under pressures up to 6-7 MPa. The catalyst is added to the system once and circulated with the recycled starting material (25-35 percent of the raw material undergoing refining). Experiments in which the new hydrogenation refining process was used to process bitumen resulted in a 92-95 percent yield of 180-520°C distillate fractions that may be used to produce motor fuel and made it possible to achieve a 20-25-percent increase in the depth of refining (to 85-90 percent). A unit for implementing the new process was designed. The unit, which has a capacity of 1 million metric tons of bitumen annually, is designed to operate as a component of an oil refinery processing 16 million metric tons of petroleum each year. The Mineral Fuels Institute and Grozgipronefteklhim also conducted a systematic study of the raw material base available for producing motor fuel from the coal of various deposits of the CIS and other countries. The CT-5 Pilot Production Plant, which was constructed in Tula Oblast during the course of the research, has been the site of extensive research directed toward improving the ecological safety of motor fuel. At the plant, processes have been developed for the following: producing coal-based methanol; synthesizing high-octane oxygen-containing gasoline additives, e.g., methyl-tert-butyl ether [MTBE], based on the C_4 by-product gases from coal liquefaction; and producing motor fuels from coal. To process coal liquefaction products into motor fuels and their components and into a raw material for producing aromatic hydrocarbons and industrial oils, the Mineral Fuels Institute, All-Russian Petroleum Refining and Petrochemical Industry Scientific Research Institute [VNIINP], and All-Russian Petrochemical Processes Scientific Research Institute [VNIIneftekhim] have jointly developed a number of processes, including hydrofining, hydrocracking, and catalytic reforming involving the use of commercial and new original catalysts. All of the new processes may be implemented on domestically produced equipment and in accordance with the process flows now used at oil refineries. The said processes have been used to produce four motor fuels (TS-1, T8-V, diesel, and ship) and three types of gasoline that all conform to the respective All-Union State Standards [GOST]. It has been estimated that the new refining processes will make it possible to process 20,381,000 metric tons of coal from the Kansk-Achinsk Basin annually into the following (millions of metric tons): AI-93 gasoline for motor vehicles, 1.000; T-8V fuel, 0.300; hydrofined type L diesel fuel, 2.715; benzene, 0.061; toluene, 0.005; and MTBE, 0.281. Estimates also indicate that the capital investments required to implement the new refining processes may be recouped in 6.2 years and that the processes will have an overall profitability of 16.0 percent. Figures 2, tables 7; references 13: 10 Russian, 3 Western.

Spectropolarization Characteristics of Optical Radiation Reflected From Plant Leaves Injured by Bacterial Cancer

957C0042 Minsk ZHURNAL PRILADNOY SPEKTROSKOPII in Russian (manuscript received 28 Apr 93)Vol 60 No 3-4 Mar-Apr 94 pp 226-232

[Article by V. I. Shuplyak, Yu. I. Atrashevskiy, V. V. Sikorskiy et al.; Belorussian State University, Minsk]
UDC 535.361+528.8

[FBIS Abstract] Analysis of how a change of structure of plant tissue damaged by bacterial cancer affects spectral-polarization characteristics of reflected radiation employed laboratory experiments on a device for measuring the angular dependence of the degree of polarization radiation, reflected by leaves of Kalanchoe daigremontiana plants infected by bacterial cancer Agrobacterium tumefaciens IDI. Each plant contained healthy and diseased leaves and the cancerous tumor, after grafting to the leaf blades, did not spread to other parts of the plant. The spectropolarization measurements provided much more information than was obtained from traditional spectral meaurements. The study showed that: development of the disease increased the fraction of singly and multiply scattered radiation by the plant tissue and features of the structure of the function degree of polarization valve length of radiation angle of incidence of light flow (P) of the infected plant indicated changes in the intracellular structure of the tissue especially changes of the function of distribution of intracellular particles by sizes due to increase of the relative number of comparatively small particles, less than 2.5 mkm. Decrease of photosynthetic activity in infected parts of plants shifted the position of the peak of (P) and changed the structure of the curve as a whole. Figures 2; references 11: 9 Russian; 2 Western.

Use of Extra-corporeal Detoxification for Peritonitis in the Multiple-Organ-Insufficiency Phase

957C0073 Moscow KHIRURGIYA in Russian No 7 Jul 94 [manuscript submitted 26 Jan 94] pp 19-23

[Article by Professor A. I. Lobakov, A. V. Vatazin, A. M. Fomin, Ye. Yu. Andriyanova, L. Ya. Abakumova, Moscow Oblast Scientific Research and Clinical Institute imeni V. F. Vladimirskiy]

[FBIS Abstract] Results are analyzed of the use of filtration and combined techniques for extracorporeal detoxification that were developed over a 10-year period at the Center for Restorative and Reconstructive Surgery of the Abdominal Organs at the M. V. Vladimirskiy Moscow Oblast Scientific Research and Clinical Institute. The most recent series of studies of the techniques involved 201 individuals, most of whom had had multiple surgical interventions for progressive peritonitis and serious pyoseptic complications. Some 75 percent of the individuals presented with a syndrome in which toxic nephropathy predominated; 65 percent had toxic hepatopathy. Specifically, the researchers developed a series of filtration plasmapheresis techniques—bifiltration cascade exchange plasmapheresis, portoplasmapheresis, and oxyplasmapheresis. The first technique consists in the following: after plasmapheresis, the blood cells (without the plasma) go to a special device in which they are washed and undergo liquid oxygenation. The liquid used for washing the erythrocytes is removed with hemofilters or plasma filters along with the toxins washed from the cell membranes. Cardiovascular system function was found to be enhanced after the technique. The portoplasmapheresis, described as selective extracorporeal detoxification of portal blood, was used successfully in peritonitis patients to treat toxic hepatopathy. In the oxyplasmapheresis, oxygen flow and consumption were improved largely as a result of increased minute volume. The researchers also developed a hemofiltration technique for patients with toxic nephropathy, toxic myocardiopathy, and respiratory distress syndrome among adults, which effected the local pulmonary dehydration mechanism of hemofiltration. Lethality figures were 20 percent lower than in the control group. References 7 (Russian).

Effect of Vaccine Strain of Plague Microbe on Expression of C3-receptors on Surface of Peritoneal and Alveolar Macrophages

957C0077A Kiev MIKROBIOLOGICHNYY ZHURNAL in Russian (manuscript received 23 Dec 92 Vol 56 No 4 Jul-Aug 94 pp 25-29

[Article by G.I. Vasil'yeva, L.N. Tkachenko, Ye.P. Doroshenko, Kh.P. Gamleshko and T.A. Balatskaya, Rostov-on-Don Scientific Research Anti-plague Institute]
UDC 616.981.452:612.017

[FBIS Abstract] The effect of the vaccine strain of the plague microbe on expression of C3-receptors (C3R) during interaction with macrophages in vitro and in vivo was described and discussed. It was established that, in the process of formation of anti-plague immunity, activation of macrophages occurred, being accompanied with an increase of expression of C3R on the outer surface of the membrane of both peritoneal and alveolar macrophages. Maximum C3R activity in both populations of macrophages is seen on the 7th day after vaccination. Immunization by the vaccine strain of plague microbe did not ch ange the nature of the response of peritoneal and alveolar macrophages to their interaction with this microorganism in vitro—there was seen a decrease of C3R expression on the surface of both populations of cells obtained from both intact and immunized animals. Heterogeneity of the populations studied in regard to C3R expression appeared in both the intact and the immune organism. Figures 2; references 6: 4 Russian, 2 Western. 02791

Peculiarities of Interaction of Azototbacter Chroococcum 20 with Highly-dispersed Silicon Dioxide

957C0077B Kiev MIKROBIOLOGICHNYY ZHURNAL in Russian (manuscript received 19 Feb 93) Vol 56 No 4 Jul-Aug 94 pp 30-35

[Article by L.V. Titova, I.K. Kurdish; A.S. Gordienko, et al; Institute of Microbiology and Virology, Ukrainian Acadamey of Sciences, Kiev] UDC 579.81.21

[FBIS Abstract] A study of electrophoretic mobility (EPM) of Azotobacter chroococcum cells as a function of the phase of development of the culture was described and discussed. At all stages of growth of the microorganisms studied sorption of aerosil A-300 on the surface of the azotobacter cells was observed. The insignifcant reduction of EPM of the azotobacter after its interaction with aerosol may indicate adhesion of the aerosil only to specific parts of the cell surface, which is confirmed by electron microscopic studies. The observed increase of growth activity of the azotobactera after its interaction with the dispersed materials was not accompanied with adsorption of components of the medium on the aerosil surface. Evidently this effect is caused by contact interaction of the bacteria cells with aerosil particles. Figures 3; references 27: 14 Russian; 13 Western.

Amplification of Integrated Transgene of Bovine Growth Hormone Gene by Method of Polymerase Chain Reaction

Moscow GENETIKA in Russian (manuscript received 2 Nov 92) Vol 29 No 6 Jun 93 pp 905-913

[Article by A.B. Zhadanov and G.A. Dvoryanchikov, Institute of Gene Biology, Russian Academy of Sciences, Moscow; All-Union Scientfic Research Institute of Physiology, Biochemistry and Nutrition of Farm Animals, Russian Academy of Agricultural Sciences, Borovsk, Yaroslav Oblast] UDC 575.590

[FBIS Abstract] Conditions of polymerase chain reaction amplification of unique fragments of bovine growth hormone (bGH) gene, which permits reliable identification of transgenic rabbits for this gene, were found. Physical integrity of the integrated contruction for one of the transgenic rabbits was shown by means of amplification of a -2000 pn long fragment, including part of the MT-promotor gene of metallothionein and chromosomal gene bGH. Using BG3 and BG4 primers, we were able, by means of amplification and sequencing of pVUII-restriction of a fragment of bGH gene, to find, among 46 newborn lambs, two animals transgenic for the bGH gene. This demonstrated the possibility of successful amplification of growth genes of swine and sheep with the use of BG3 and BG8 primers, corresponding to the beginning and end of the bGH gene. Figures 8; References 12: 2 Russian, 10 Western.

Cloning recA and lexA Genes on Plasmid with Broad Spectrum of Hosts

Moscow GENETIKA in Russian (manuscript received 2 Nov 92) Vol 29 No 6 Jun 93 pp 914-921

[Article by S.V Pankova, V.A. Tarasov and S.K. Abilev, All-Union Scientific Research Institute of Genetics; Insitute of General Genetics imeni N.J. Vavilov; Russian Academy of Sciences, Moscow] UDC 575:579.842.11

[FBIS Abstract] The recA gene from Escherichia coli and Propionibacterium shermanii and the lexA gene from E. coli were cloned in the polylinker of plasmid pB1101 with a wide spectrum of hosts. We studied the dependence of induction of SOS-response on the dose of UV-irradiation and methylmethan-sulfonate, 4-nitro quinoline-1-oxide was studied in E. coli cells carrying this plasmid and SOS-restricting plasmid pJE43. It was shown that the level of SOS-response in recA cells, carrying plasmids pBI101::recA, both in the case of recA gene of E. coli and P. shermanii essentially exceeded the level of SOS-response in EC1000 cells with normal functioning recA-gene. However, during introduction of pBI101 plasmid(s) with two cloned genes (recA and lexA), complete complementation of expression of SOS-functions in recA-cells of E. Coli under the effect of all three mutagenic factors did not proceed. Figures 4; references 8: 3 Russian, 5 Western.

Cloning Gene R1B7, Encoding Riboflavin Synthase of Pichia Guilliermondii Yeasts

Moscow GENETIKA in Russian (manuscript received 2 Feb 92) Vol 29 No 6 Jun 93 pp 923-927

[Article by E.M. Logvinenko, Yu.Z. Stasiv, M.L. Zlochevskiy, et al; L'vov Department of Institute of Biochemistry imeni A.V. Palladin; Ukrainian Academy of Sciences, Scientific-R esearch Institute of Technology, Moscow] UDC 577.21:579.842.11

[FBIS Abstract] R1B7 gene, encoding the enzyme of the final stage of riboflavin biosynthesis in yeasts Pichia guilliermondi-riboflavin synthase, was cloned on the pFL38 shuttle vector in the form of Sau3A-fragment of chromosomal DNA in the size of about 4kb. A Hind III fragment, about 1.4 kb in size, containing R1B7 gene, was recloned from the hybrid plasmid pF57 obtained in plasmid pUC18. Plasmid PR7 thus constructed forms cells of mutants of Escherichia coli of ribB-45 with blocked riboflavinsynthase at the same frequency as plasmid pFR7. The high riboflavinsynthase activity was found in E. coli transformants; complementation of mutant P. guilliermondi rib7 was also realized. Synthesis of riboflavinsynthase of transformants is regulated by iron as in wid type cells. Figures 2; references 11: 8 Russian, 3 Western.

Russian Tomograph Reviewed

957C0087A Moscow VRACH in Russian No 2 Feb 94 (signed to press 17 Feb 94) p 23

[Article by V. Smirnova: "MR Tomograph—a New and Effective Resource in Diagnostic Arsenal"]

[FBIS Translated Text] Magnetic-resonance tomography (MRT [magnetic resonance imaging]) occupies a special place among classical and modern methods of diagnostic radiation. The advantages of MRT, as compared to traditional diagnostic x-ray procedures include, first of all, absence of radiation burden, which permits numerous examinations. Moreover, among the advantages of MRT we can mention the possibility of obtaining an image of an organ in any plane without moving the patient or scanning device, wider range of contrast when examining soft tissues, high spatial resolution, as well as possibility of examining such extremely important functional characteristics as velocity of biological fluids, acid-base equilibrium in tissues, and others.

The first domestic whole-body MR tomograph, Obraz-1 [Image], developed by the Agregat Corporation joint-stock company and Az NPF [Scientific Production Factory], underwent successful clinical trials in July 1990 in the neurointroscopy laboratory of the Research Institute of Clinical Psychiatry, and the USSR Ministry of Health granted permission for its serial production on the basis of these trials.

In a single year, the Obraz-1 MR tomograph was used to examine 848 patients with pathology of the brain (476 people), spinal cord and spine (251), organs of the abdomen, retroperitoneal space and pelvis minor (62), and large joints (23).

As shown by the results of comparing tests on the x-ray tomograph of the Simens firm and our Obraz-1 revealed that the capability to demonstrate diverse forms of pathology (of vascular genesis, tumors, atrophic processes) on the MR tomograph are appreciably greater thanks to use of special diagnostic maps for parameters of T_1 and T_2 relaxation and ability to view examined sections in any plane. Obraz-1 is notable for a high degree of reliability thanks to the absence of moving parts and ionizing elements, high resolution and high speed of processing information.

A study was carried out at the Research Institute of Clinical Psychiatry to assess the effectiveness of software and hardware in the Obraz-1 tomograph for detection of diseases of the brain.[1] The indications for an MRT examination of patients were: presence of acute cerebrocirculatory disturbances, clinical signs that suggested an intracranial process, as well as presence of tumors in other organs and systems (in order to detect possible metastases to the brain).

It was shown that the overall effectiveness of MRT in detection of focal changes in the nervous system and assessing the condition of various parts of the spinal fluid-containing space and identifying structural abnormalities of the brain constituted 56.7 percent. The frequency of detecting cerebral pathology was at a maximum in patients with suspected organic brain lesion, and at a minimum in those with the epileptiform syndrome and advanced age dementia. Frequency of detection of intracranial lesions in patients with schizophrenia and bipolar psychosis was almost twice as high as with a KT [computer tomography?]. On the whole, precision of MRT in identifying most pathological processes in the brain, particularly when localized in the stem, was noticeably higher than simple KT.

Effectiveness of MRT is quite high in detection of cerebral edema, which is a serious complication of many diseases of the nervous system, and in differentiation between vasogenic, cytotoxic and ischemic types of edema. A comparison of the results of MRT and KT in patients with brain disease revealed that in 12.5 percent of the cases MRT picks up pathology that is not found with KT and in 8 percent of the cases the diagnosis made using KT was changed because of the higher sensitivity of MRT. It was shown that MRT is less effective than KT in diagnosing lesions with insignificant concentration of protons. But MRT was considerably better in identifying cerebral focal changes in patients with hemorrhagic and ischemic accidents. Thus, zones of ischemic edema of the brain arising within the first hours of illness can be detected on T_2 suspended images 6-9 h after appearance of clinical signs of cerebrocirculatory disturbances, whereas positive KT diagnosis of foci of incipient brain tissue necrosis is usually possible after 24-48 h and with localization of lesion in the supratentorial structures. MRT is very important in the detection of developmental brain defects, in particular, in the cerebrospinal anatomical region, corpus callosus, ventricular system, subarachnoid space, which often develop in the prenatal and early postnatal periods.

The results of examining patients using the first Russian Obraz-1 tomograph confirmed that it is simple to control and reliable in operation. The pulsed sequences in it provide for higher diagnostic precision, as compared to KT (with the exception of lesions with low content or no protons), and permit formation of new variants of pulsed sequences, depending on the purpose of the test, and this creates conditions for comprehensive examination of the nature of detected pathological changes in nerve tissue.

Experience with the Obraz-1 MRT at the medical center of Novolipetskiy Metallurgical Combine indicates that the technique is highly informative in identifying tumors of the retroperitoneal space, kidneys, pancreas, mediastinum, and in assessing extent of bone involvement in the presence of aseptic necrosis, osteoma, and osteomyelitis. Examination of the tested organ in three planes permits more precise evaluation of severity not only of lesion to the organ proper, but

also adjacent topographic disturbances. Data on size and localization of neoplastic nodes in the uterus obtained by MRT of organs of the pelvis minor in women with genital endometriosis were more reliable than data obtained previously with ultrasound examination, which enables the physician to select more specifically a method of treatment. In 2.5 years, MRT examinations were made of more than 300 people with pathology of organs in the abdominal cavity, chest, retroperitoneal space, pelvis minor (men and women), and musculoskeletal system. The findings were subsequently confirmed during treatment, particularly with surgical management.

Thus, the clinical use of the Russian MR tomograph has confirmed its wide diagnostic capabilities.

Footnotes

1. S.B. Vavilov, "Magnetic Resonance Tomography in Identification of Brain Pathology," MEDITSINSKAYA RADIOLOGIYA, 1992, No 2, pp 28-33.

Antineoplastic Effect of Rotational Magnetic Field

957C0087B Moscow VRACH in Russian No 2 Feb 94 (signed to press 17 Feb 94) pp 25-26

[Article by V. Smirnova]

[FBIS Translated Text] Experimental studies of the effect of a rotational magnetic field (RMF) with preset characteristics on *in vitro* cultures of human tumor cells and experimental tumors in animals, which were carried out at the Oncological Research Center of RAMN [Russian Academy of Medical Sciences] demonstrated its direct destructive effect on tumor cells (depression of DNA synthesis) *in vitro* and substantial antineoplastic effect *in vivo*. Inhibition of growth of experimental carcinoma of the breast constituted 70-80 percent, that of melanoma—60 percent, and lung tumors—50 percent. With numerous exposures to RMF there was 26-44 percent inhibition of metastases of experimental highly metastatic tumors in mice. Total body exposure to RMF of animals elicited increase infunctional activity of cells of natural antineoplastic resistance (neutrophils, macrophages) as a result of increased production of free radicals of oxygen with concurrent increase in chemoluminescence of whole blood. These results served as grounds to develop an original method of RMF therapy combined with radiation and cytostatic therapy for oncological patients.

Clinical studies of the effect of RMF on locally spread forms of breast cancer using this technique were carried out following a specially elaborated program, which included preoperative combined treatment with total body RMF therapy, surgical resection of the tumor and a course of postoperative chemotherapy combined with RMF therapy. The findings are indicative of absence of any side-effects (inflammation, other complications) after use of RMF. Postoperative examination of patients revealed satisfactory results.

The Magnitoturbotron-1 unit developed jointly by the staff of the Kuban Medical Institute and Az NPF [scientific production factory?] was used to administer total body RMF therapy. The voltage of RMF per cycle was gradually raised from 0 to the specified maximum level, then lowered back to 0.

The Magnitoturbotron-1 unit was used at the Kuban Medical Institute for treatment of patients with generalized and localized breast cancer.[1]

The group with generalized forms of breast cancer consisted of 68 women with primary incurable tumor, recurrences, intradermal and subcutaneous metastases, metastases to regional and contralateral lymph nodes, the second breast, lungs, bones, and brain. Treatment was started at least 2 months after termination of another form of therapy in the presence of obvious signs of progression of the disease. The results were assessed after giving 30 RMF treatments each lasting up to 60 min. Dramatic improvement was noted in 21 cases (tumor and metastases diminished by more than 50 percent), and substantial improvement (25-30 percent reduction) in 11 cases. A more than 50 percent reduction in tumor elements was observed mainly among patients with metastases to soft tissues: subcutaneous, intracutaneous, and metastases to the lymph nodes. Remissions lasted 4-180 months.

RMF therapy was administered to 53 patients with localized grade II-III breast cancer, before and after surgery, giving 30 treatments to each. The area of neoplastic nodes constituted 15 to 54 cm before RMF therapy, and it decreased by 30 percent as a result of treatment. Cumulative survival for all intervals (interval method of tabulating survival time) constituted 95.6 percent.

The Az NPF developed and manufactured improved versions of this unit: Magnitoturbotron-2 and Magnitoturbotron-2M.

At the present time, Magnitoturbotron-2 is used at the Oncological Research Center of RAMN in combined treatment of patients with breast cancer. The experience gained gives us grounds to recommend this unit for combined treatment of oncological diseases in specialized medical institutions. The unit may be beneficial for secondary prevention of metastases in the postoperative period.

Magnitoturbotron-2 is used at the Moscow Research Institute of Diagnostics and Surgery in the treatment of neoplastic and non-neoplastic (osteochondrosis, polyarthritis, peptic ulcer, cardiovascular pathology, and others) pathology. To date, 82 people have been treated with this unit: 70 with oncological pathology, including 7 with breast cancer, 8 with lung cancer, 13 with carcinoma of the stomach, 5 with renal cancer, 4 with

carcinoma of the female reproductive system and 3 with melanoma of the skin. Among these cases, there were 63 with generalized stagess of disease, and 7 had undergone radical oncological surgery. In all of the patients, the diagnosis of malignant neoplasm was confirmed by morphological tests of the primary tumor and metastases.

The course of RMF therapy consisted of 12-30 treatments administered daily with the following RMF parameters: 6000 rpm frequency of rotation, 120 s cycle, 3 mT magnetic induction. Duration of each treatment was determined on the basis of the patient's temperature reaction.

Efficacy of therapy was assessed on the basis of clinical examination of patients before and after therapy (ultrasound, x-rays, CBC, and others). A positive response to RMF therapy in the form of diminished pain, improved well-being, normalization of temperature and blood indicators was noted in all patients with non-oncological pathology, as well as oncological patients with carcinoma of the kidney, breast, and skin melanoma. During treatment, there was reduction in tumor size, change in its consistency, and increase in mobility; stabilization of the process for 6 to 24 months was noted in 50 percent of the patients.

Thus, experience with RMF therapy for malignant neoplasms of diverse localization revealed that it elicits a positive clinical response. At the present time, work is in progress to expand the area of medical application of the magnetic therapy unit in clinics of Moscow, Krasnodar, Minsk and Akmala.

Footnotes

1. N. G. Bakhmutskiy et al., "Use of Rotational Magnetic Field in the Treatment of Breast Cancer," "Lazernaya i magnitnaya terapiya v eksperimentalnykh i klinicheskikh issledovaniyakh—Tez. dok." [Laser and Magnetic Therpay in Experimental and Clinical Studies—Summaries of Papers], Pt II, Obninsk, 1993, pp 203-204.

RAMN Department of Preventive Medicine

957C0087C Moscow VRACH in Russian No 2 Feb 94 (signed to press 17 Feb 94) p 43

[Article by Ye. Fedorov, candidate of medical sciences, deputy academician-secretary, RAMN Department of Preventive Medicine]

[FBIS Translated Text]The RAMN [Russian Academy of Medical Sciences] Department of Preventive Medicine, which is headed by Academician-Secretary N. Izmerov, unites major scientists—specialists in general and communal hygiene, occupational medicine, hygiene of nutrition, social hygiene and public health organization, microbiology, virology, molecular biology, genetics of microorganisms and gene engineering, infecitous immunology, parasitology, epidemiology, chemotherapy of viral infections, antibiotics, and others.

The Bureau is the administrative body of the Department, and its structure comprises two sectors: "Medical aspects of human ecology" and "Infectology"; these sectors consist of different specialized sections.

Not only Academy members, but also highly qualified specialists in research institutes of both the RAMN and other agencies are called upon to work in these sectors.

The Department supervises the activities of institutes it comprises, it defines the main directions and is responsible for development of basic and applied research in the relevant branches of medicine both within the limits of RAMN institutions and other agencies involved in developing comprehensive government, industrial and interagency progrmas of research that are formed by the RAMN.

The Department implements coordination and planning of research in the nation in the field of preventive medicine by means of seven interagency scientific councils and the 41 problem commissions (PC) they include: for human ecology and hygiene (7 PC), social hygiene, economics and health care management (3 PC), medical problems of nutrition (4 PC), microbiology (6 PC), virology (10 PC), epidemiology, parasitic and infectious diseases (6 PC), nosocomial infections (3 PC), and antibiotics (2 PC).

The Department consists of 11 research institutes: Institute of Human Ecology and Environmental Hygiene imeni A. N. Sysin; Institute of Occupational Medicine; Institute of Nutrition; Institute of Social Hygiene, Economics and Health Care Management imeni N. A. Semashko; Institute of Epidemiology and Microbiology imeni N. F. Gamaleya; Institute of Vaccines and Sera imeni I. I. Mechnikov; Institute of Virology imeni D. I. Ivanovskiy; Institute of Viral Preparations; Institute of Poliomyelitis and Viral Encephalitis; Institute of Influenza; New Antibiotics Research Institute, as well as an independent laboratory for medical problems of the North (city of Nadym).

We hope that the articles by Department scientists submitted below will be of interest to practicing physicians as well.

Academicians on Low Russian Vaccination Rate

957C0087D Moscow VRACH in Russian No 2 Feb 94 (signed to press 17 Feb 94) pp 43-44

[Article by A. Vorobyev, academician of RAMN. Moscow Medical Academy imeni I. M. Sechenov: "More About Inoculations"]

[FBIS Translated Text] Infectious diseases continue to cause much harm to mankind. Their incidence on our planet is in second-third place among other diseases. In other words, every second-third patient, even in such a civilized country as the United States, has an infectious disease. And 7 out of the 10 diseases that are the chief

causes of death (respiratory, cardiovascular, gastrointestinal, measles, trauma, oncological, tetanus, viral hepatitis, malaria, tuberculosis), are infectious. The economic loss from infectious diseases amounts to tens of billions of dollars annually. Suffice it to recall the enormous funds allocated for the control of AIDS. These funds are spent on epidemic-control, therapeutic, diagnostic and preventive measures that cover entire peoples and continents.

In the last decade, not only has the incidence of infectious diseases failed to decline, it even had a tendency toward rise. This applies in full to Russia and other CIS states where the incidence of diphtheria, measles, poliomyelitis, pertussis and others has grown. Social tension, poorer standard of living, deterioration of sanitary and hygienic conditions, the miserable condition of medicine, migration and others can be considered the main causes. In addition, there are occupational, organizational and psychological causes. The fact of the matter is that one can produce immunity to a number of infectious diseases by means of vaccination. As an example there is eradication from the globe of an extremely dangerous infection—smallpox, as well as virtual eradication of epidemics of diphtheria, polio, measles, and others.

At the present time, the medical preventive service has an arsenal of dozens of effective vaccines. There is a government-established calendar for inoculations in every country, including Russia, which regulates mandatory vaccination of specific population categories throughout their lives. Epidemiologists are well aware of the fact that prevention of epidemics and mass disease is possible only if at least 90-95 percent of those at risk are inoculated. However, regrettably coverage with inoculations in our times does not, in some cases, exceed 30-40 percent. This is where the evil lies. As an example, we can mention diphtheria. In our country, where only 30-40 percent of the child population is vaccinated against diphtheria, its incidence is about 2000 times (!) higher than in the United States where 95 percent of the children are vaccinated annually. Yet the quality of the preventive product, diphtheria toxoid, is the same both in our country and in the United States.

Wherein lies the cause of the low coverage of the people of the Russian Federation with inoculations? In the first place, because of the fear of possible transmission of HIV infection through syringes, part of the population is compelled to refuse inoculations. In the second place, in the presence of all sorts of disclosure campaigns, there have been numerous publications, transmissions via radio and television about the harm of vaccination in our country. Let us recall at least the notorious campaign about the harm of the preservative, merthiolate in vaccines, which scared off some of the uninformed public. In the third place, the quality of some vaccines (against tuberculosis, measles and others) has diminished for production and economic reasons. And, finally, the very organization of inoculations has worsened.

Enormous world experience in immunoprophylaxis of infectious diseases is indicative of the lack of justification for the propaganda about the harm of vaccination. As is the case for any foreign substance injected in the body for therapeutic or preventive purposes, vaccines induce undesirable side-effects in some people in the form of local and systemic reactions (erythema, edema at the site of injection, fever, worsening of well-being), which constitute the normal process of the body's reaction to vaccination. Complications, which occur in isolated instances, may be due merely to some flaws in administering inoculations (inadequate sterility, failure to consider contraindications, etc.). When all rules for vaccination stipulated in official instructions and directions are followed, there is also no real danger of transmitting "syringe" infections (AIDS, syphilis, viral hepatitis, malaria). This is indicated by the hundreds and hundreds of million inoculations administered in different countries of the world.

The level of development of production at the present time makes it possible to obtain high-grade vaccines. A new generation of vaccines has also appeared, which were obtained by the latest methods of immunobiotechnology and gene engineering. A genetically engineered vaccine against hepatitis B is already being used in clinical practice; synthetic vaccines are being developed against a number of viral and bacterial infections, and live vector vaccines. The quality of vaccines is improving, referring not only to their immunogenicity, but also safety, as a result of removing inactive ingredients from antigen. More sparing, adequate methods of administering vaccines have been developed (by mouth, inhalation). Vaccination techniques are being improved (jet injections). Immunoprophylaxis of infectious diseases is developing in all directions. However, even with availability of an adequate number of safe and effective vaccines, one cannot eradicate certain infectious diseases without mass coverage of appropriate population groups with inoculations, i.e., without mandatory inoculation of 90-95 percent of those who should be vaccinated. Until we achieve this, people will suffer and die from diseases that could be easily prevented. The annual death of 4 million children in the world due to measles and pertussis, 1.2 million children and adults due to tetanus, and millions of people due to other infections against which there are effective vaccine is an absolutely unwarranted disgrace.

DV Molecules: A New Ecological Hazard in Every Home

957C0087E Moscow VRACH in Russian No 2 Feb 94 (signed to press 17 Feb 94) pp 44-45

[Article by A. Kulberg, corresponding member of RAMN, RAMN Research Institute of Epidemiology and Microbiology imeni N. F. Gamaleya]

[FBIS Translated Text] In recent years, microorganisms that are free-moving saprophytes and previously believed to be harmless to man have begun to present a significant threat to his health. Their interaction with man has grown more frequent due to his ever increasing pressure on nature. At present, physicians already know of numerous cases of disease caused by such microorganisms as Yersinia, Klebsiella, Legionella, and a number of others that became pathogenic as a result of change in their genetic system. Very recently, some dangerous signs appeared to the effect that impairment of ecological equilibrium on regional and global scale (general warming, increased concentration of carbon monoxide in the atmosphere and, apparently, diverse industrial pollutants of the air, water and soil) is arming against man one of the most numerous groups of microorganisms that are extremely important to life on earth—unicellular blue-green algae. As we know, they excrete most of the oxygen into earth's atmosphere. However, according to the most recent data, including those gathered by aerospace reconnaissance, compelled this biological genus to trigger life-support mechanisms that could be extremely hazardous to man and other living organisms.

About 2 years ago, the staff of our laboratory began a systemic observation of bioorganic substance levels in tap water. Water in water-supply systems of several capital cities, first of all Moscow and Washington, natural sources of fresh water and water treated by different methods was tested. The results turned out to be quite important and, in many respects, unexpected.

Thus, it was discovered that all tap water always contains polymer molecules that are highly active in extremely low concentrations, and it was subsequently learned that they are of bacterial origin. These molecules, which were named DV molecules, were studied comprehensively using physical and biochemical methods. It was found that they can bind ions of transition metals, for example, copper, forming compounds that can in rather low concentrations interact with active forms of oxygen and water, becoming catalysts of oxidative processes. Evidently this is why DV molecules can express themselves as a mutagen and affect various human cells *in vitro*. In particular, DV molecules elicit so-called polyclonal activation of peripheral blood lymphocytes, concurrently depressing lymphocyte reactions to phytomitogens. At the same time, DV molecules prevent expression of the cytotoxic effect of natural killer lymphocytes on tumor cells. It is opportune to recall that apparently natural killers are one of the main systems of protection against malignant cell growth. Thus, there is every justification to assume that DV molecules can raise the risk of neoplastic processes.

Among other rather alarming manifestations of DV molecule activity is the property to suppress the activity of cutaneous cells, and to depress activity of digestive enzymes. It is not surprising that young animals given tape water after removal of DV molecules from it gained weight reliably faster than control animals on the same diet. Moreover, natural killer activity was higher in the former, and they produced antibodies more intensively after immunization with standard antibodies, even without special induction they produced serum interferon (these findings were reported at an international conference on interferons and cytokines in Tokyo).

Unpleasant properties of DV molecules include resistance to boiling and retention of activity in chlorinated water. It is not simple to get rid of DV molecules. They only appear after deionizing the water. Although distilled water with added calcium ions is wanting in essential trace elements, it is a consumer product and used extensively in the United States. It served as the purity standard in our experiments. The medical and hygienic qualities of such water without needed trace supplements can be understood by everyone. However, even consumers of distilled water must be on the alert: it is often severely contaminated with DV molecules at the condensation stage, and the reasons for this will be discussed below.

Where did the DV molecules in water come from?

In collaboration with specialists from the Biology Department of Moscow State University, we designed an immunological system and using it established that DV molecules are analogues of the molecules that blue-green algae produce in an environment that is uncomfortable for them. Evidently, they are also produced by bacteria related to algae that inhabit the surface of various piped water systems. Thus, DV molecules get into distilled water too and, probably, many other products containing water. If we add that DV molecules are capable of being sorbed on the surface of protein molecules, the hazard they present to man grows even more obvious. The levels of DV molecules in water, including tap water, are variable. We recorded peak concentrations in tap water of Moscow and Washington in periods between seasons. Such a bioclimatic "disaster" is definitely related to disruption of vital functions of blue-green algae, which is consistent with the data of ecologists.

Thus, ecological troubles reach every house right in the water. The enormous number of living organisms that are trying to save themselves unintentionally threaten each of us. Something that could help a unicellular organism in a natural habitat may suppress immunoreactivity, impair digestion, inhibit regeneration of the integument and even cause mutation changes in the genetic system of man and higher animals. Man, higher

animals, birds, fish and plants consume large amounts of water; it is in the natural cycle, which makes it dramatically more difficult to find a medical and hygienic solution to the problem. It is imperative to monitor DV molecule levels in water, foods, drugs, cosmetics, etc. as a priority step and refine as soon as possible the technology for purifying drinking water. The means of implementing these steps have been found, and with the proper organizational and funding base practical results could be reached in a short time. As for scientific and ecological aspects of the problem, there is enough work for many years. To postpone both scientific and applied research on this problem is tantamount to suicide. Let no one be embarrassed by this strong comparison: after all, the living mass of blue-green algae apparently exceeds by billions of times the total living mass of all higher organisms, including man. One should handle such an ocean of living things with much respect.

Parenteral Hepatitis

957C0087F Moscow VRACH in Russian No 2 Feb 94 (signed to press 17 Feb 94) pp 46-47

[Article by S. Klimenko, corresponding member of RAMN, RAMN Research Institute of Virology imeni D.I. Ivanovskiy]

[FBIS Translated Text] Since the mid-1980s the problem of viral hepatitis and, in particular, parenteral forms (B, C, D) has moved to the background due to the beginning of the AIDS epidemic. Funding of research on hepatitis B was at minimum, and at that time the former USSR Ministry of Health did not find the needed resources to produce vaccine by gene engineering.

At present, the Russian Federation is the only nation in the world where large scale vaccination against hepatitis B is not practiced. It should be noted that the vaccine against hepatitis B also provides effective protection of people against hepatitis D. Thus, there is no specific prevention in our country of hepatitis B and D, and there are quite a lot of unsolved problems in the system of measures for nonspecific prophylaxis. According to official records, the emerging trend toward decline of morbidity from 36,800 in 1989 to 26,800 in 1992 is merely the result of the fact that at the present time only cases with marked symptoms and, first of all, with icterus are recorded, while the share of such cases among all cases of acute hepatitis is one-third. Moreover, there is every reason to believe that by far not all cases with the icteric form get into the official records. Thus, in regions adjacent to Central Russia the morbidity rate per 100,000 population can vary considerably: in Pskov Oblast it is one-third the level in neighboring Novgorod Oblast. And this is not an isolated example.

Thus, on the whole the situation remains serious. It would not be an exaggeration to believe that there are at least 100,000 new cases annually in the Russian Federation. What is their prognosis?

In patients with icterus, the clinical course ranges from moderate to fulminating hepatitis with lethal outcome in 1-1.2 percent.

Acute hepatitis (for B, C, D together) does not result in recovery in 10 percent of the cases. The disease becomes chronic, and chronic persistent hepatitis (CPH) has a tendency toward changing into chronic active hepatitis (CAH), and the latter, into cirrhosis of the liver. The time frame for this process varies and, apparently, there are various cofactors, among which alcohol does not play the smallest part. It has been established that CAH with hepatitis D markers is more aggressive and is transformed into cirrhosis within a shorter time. Patients with CAH and cirrhosis of the liver must be hospitalized for long periods of time. The prognosis for cirrhosis is absolutely poor.

It should be stressed that when an infant up to 1 year old is infected with the virus of hepatitis B or viruses of hepatitis B and D (from the mother during labor or via any other route), the disease is usually asymptomatic and becomes chronic in 90 percent of the cases. In such patients, cirrhosis of the liver develops early and the probability of development of chronic hepatitis into primary liver cancer is higher (in the Russian Federation 8400 cases of primary liver cancer were recorded in 1992). This makes it imperative to implement mandatory vaccination of all neonates in regions where carriers of HBsAg exceed 2 percent. Expressly such a level is observed throughout the Russian Federation. It is of basic importance to note that patients with CPH, CAH and cirrhosis of the liver are sources of infection for those around them, and they must have the status of infectious patients. To date they were **not considered** to be such patients and were not subject to registration on all levels of official record-keeping. At best, they are placed in gastroenterological, but more often ordinary somatic departments which, of course, have no resources for treating infectious patients.

It is an urgent task for public health to keep records of such patients, treatment in infectious hospitals or infectious departments with clinical observation. Without such an approach we shall never have precise data about their number and, consequently, about the size of high risk groups which refers to the immediate family of patients. Moreover, there should be a number of occupational restrictions for chronic patients with markers of hepatitis B, C, and D, including some health care workers who come in direct contact with children in creches, children's homes [institutions], etc.

According to our estimates, there are 150,000 to 200,000 chronic patients in the Russian Federation. Of course, these data could be improved only through planned work on detection and registration of such cases, which will take years, but it must be started immediately.

Specific methods combined with nonspecific ones (in the case of hepatitis B and D) or only nonspecific ones (in

the case of hepatitis C) will be able to play the leading part in prevention of parenteral hepatitis.

One could achieve a significant decline in incidence of hepatitis B and D within the next 10-20 years only if vaccinations are administered to all neonates and individuals in risk groups: health care workers who handle blood, surgeons, obstetrician-gynecologists, stomatologists, family of chronic patients, children in closed children's groups (creches, children's homes) and young people 15-25 years of age. The need for this step is absolutely obvious, although some argumentation is needed with regard to young people.

According to American epidemiologists and scientists of a number of countries who are concerned with the problem of parenteral hepatitis, the viruses of hepatitis B and D are transmitted via the sexual route, not only in the case of homosexual, but also heterosexual contacts. The data of American specialists to the effect that at least 25 percent of the acute hepatitis B cases are due to heterosexual contacts are quite reliable, since virtually all other routes of transmission were ruled out. Thus, young people 15 to 25 years old, who usually have more than one sex partner and are at risk for infection with hepatitis B and D viruses from essentially healthy chronic patients, constitute a new risk group.

In the battle against hepatitis B and D, one should not overlook the fact that nonspecific methods, including dissemination of information about sanitation among chronic patients and those around them, is a powerful factor in lowering morbidity.

Replacement of the insufficiently sensitive erythrocyte diagnosticum and passive hemagglutination test (PHAT) for screening donor blood with the more sensitive immunoenzyme test system is quite promising. For this, an order must be issued to the blood donor service banning PHAT for screening blood.

As for vaccination against hepatitis B, this has been a sad subject for more than 10 years. Plasma vaccine prepared from blood with high HBsAg content was developed at the RAMN [Russian Academy of Medical Sciences] Institute of Virology imeni D. I. Ivanovskiy as far back as the early 1980s. It demonstrated high efficacy in a limited epidemiological trial.

The staff of the Biomed Enterprise, which was ordered to produce this vaccine in accordance with a decision published by the Board of the USSR Ministry of Health on 27 April 1988, has unfortunately not even started to produce experimental series.

The BIO-VTI NPO [scientific-production association] has been working on production of genetic engineering (yeast) vaccine, which was developed by three Russian research institutes—RAMN Institute of Virology imeni D.I.Ivanovskiy, RAN [Russian Academy of Sciences] Institute of Molecular Genetics, and RF Ministry of Health Institute of Immunology—since 1990, but still has no certificate for its commercial release.

Experimental production series of second generation genetic engineering vaccines are still undergoing government preclinical trials at the GISK [State Institute of Standardization and Inspection of Medical Biologicals imeni L.A.Tarasevich].

In both instances, experimental production series of genetic engineering vaccines are being produced under conditions that preclude mass production (about 10 million doses per year). It is imperative for the RF government to immediately organize such production with allocation of about $12-15 million and considerable sums in rubles, as indicated by the experience gained in the last 5 years following the 1988 decision of the USSR Ministry of Health Board. It is high time to realize that we are dealing with the health of the nation, since there is constant accumulation of chronic patients.

At present, prevention of hepatitis C is based mainly on testing for antibodies to the virus in donor blood. Modern test systems of a number of western firms permit demonstration of antibodies in blood samples in 95-97 percent of the cases. Government trials of three domestic test systems are being completed at GISK; they were developed by the Institute of Virology imeni D. I. Ivanovskiy together with the Diagnostic Systems NPO (Nizhniy Novgorod), D. Mazay joint-stock company and Research Institute of Experimental Medicine imeni Pasteur (St. Petersburg). These diagnosticums permit demonstration of 80-84 percent blood specimens containing antibodies to the virus of hepatitis C. These test systems must be immediately adopted by the blood donor service and test systems must be quickly developed that are as sensitive as foreign ones. The latter include a test system developed by the Vector NPO (Novosibirsk), which is undergoing trials at the same institute.

New Site-Specific Endonuclease BspKT5I

957A0033A Moscow BIOKHIMIYA in Russian
Vol 59 No 4 Apr 94 (manuscript received 25 Nov 93; after revision 13 Jan 94) pp 485-493

[Article by N.I. Shapovalova, L.A. Zheleznaya, N.N. Matviyenko, N.I. Matviyenko, Institute of Proteins, Institute of Theoretical and Experimental Biophysics, Russian Academy of Sciences, Pushchino, Moscow Oblast, Institute of Molecular Diagnostics and Treatment, Moscow; UDC 577.152.314'1]

[FBIS Abstract] A new site-specific endonuclease, BspKT5I, has been isolated from a thermophilic soil bacteria, Bacillus species KT5.

The endonuclease was isolated with successive chromatography in blue agarose, hydroxyapatite, and heparin-Sepharose. The endonuclease is free of interfering contaminants. BspKT5I recognizes the double-stranded DNA sequence 5'CTGAAG16N [down arrow] / 3'GACTTC14N [up arrow] [the first sequence is above

the second in the source text] and cleaves it to the side of the site, as shown by the arrows, forming a dinucleotide with 3'-protruding ends. The endonuclease is an isoschisomer of Eco57I; howeve r, in contrast to Eco57I it is not stimulated by S-adenosylmethionine and has no methylase activity. BspKT5I belongs to cla ss IIS, whereas Eco57I belongs to class IV. This is the first incidence of isoschisomers in different classes. Figures 9; table 1; references 9: 1 Russian, 8 Western.

Functional Studies of Bacteriophage T7 RNA Polymerase Mutants Containing Point Amino Acid Substitutions in Motif B of the Enzyme Active Site

957A0033B Moscow BIOKHIMIYA in Russian
Vol 59 No 4 Apr 94 (manuscript received 10 Dec 93; after revision 13 Jan 94) pp 494-502

[Article by V.L. Tunitskaya, S.M. Dragan, D.A. Kostyuk, D.L. Lyakhov, L.V. Memelova, V. O. Rechinskiy, S.N. Kochetkov; V.A. Engelgardt Institute of Molecular BIology, Russ ian Academy of Sciences, Moscow; UDC 577.152.4]

[FBIS Abstract] Monomeric DNA and RNA polymerases contain a number of structural motifs common to these enzymes. The motifs contain invariant amino acid residues in certain positions. This paper studies the functional role of amino acid residues in motif B. A number of mutant forms of RNA polymerase were obtained from bacteriophage T7 through random mutation and oligonucleotide-directed mutagenesis, and their properties were studied. These polymerases contain amino acid substitutions at motif B, in the active center of the enzyme. The mutant forms were studied fo r activity in matrices with and without a promoter, binding with the promoter and GTP, and the rate of chain elongation. If the mutant could not fully transcribe, its ability to synthesize short RNA fragments was studied. Kinetic parameters seem to indicate the participation of residue 636 in the binding of the initiating GTP, residue 639 in the selection of complementary NTP, and residue 646 in interaction with the promoter. Figures 5; tables 4; references 17: 6 Russian, 11 Western.

Interaction of Rabbit Liver Annexins with Various Bivalent Metal Ions: Competition Between the Proteins and Changes in the Order of Annexin Binding to Phospholipid Vesicles

957A0033C Moscow BIOKHIMIYA in Russian
Vol 59 No 4 Apr 94 (manuscript received 19 Nov 93; after revision 2 Dec 93) pp 568-574

[Article by V.I. Melgunov, S.M. Nabokina, Molecular Biology section, Biology Department, Lomonosov Moscow State University; UDC 577.112]

[FBIS Abstract] Little is known about annexins. Annexins are a group of structurally similar proteins that can bind with phospholipid membranes. Binding is dependent on Ca^{2+} concentration. Other bivalent metal ions may also affect binding. This paper examines the effect of bivalent metal ions on binding of annexins to liposomes. A natural mixture of annexins isolated from a rabbit liver is used with liposomes prepared from soybean azolectin. Competition between different annexins is examined. When there is a limited number of accessible binding centers, no more than 45% of the proteins drawn into the medium may bind with the liposomes. The curves of total binding of annexins in the presence of various ions differ substantially in shape. This is especially pronounced in the case of Ca^{2+} and Sr^{2+} where there are distinct binding m axima and minima. Annexin binding is dependent on ion content. Ba^{2+} may have some inhibiting effect on proteolysis. When Co^{2+} is present all annexins begin to bind simultaneously. The order of binding of various annexins differs when Sr^{2+}, Mn^{2+} and Ni^{2+} are present. Lipid composition also has a substantial effect on binding. Each annexin seems to have a set ion concentration at which it binds. As binding begins, the first annexins bind at high Ca^{2+} concentrations; as the Ca^{2+} levels drop, more annexins are activated, causing a bind ing sequence. Annexins may only be one part of a complex intracellular system interacting with various bivalent metal ions. Figures 2; references 44: 7 Russian, 34 Western.

Ergot Strain Identification Using Electrophoretic Analysis of Sclerocial Body Proteins

957A0033D Moscow BIOKHIMIYA in Russian
Vol 59 No 4 Apr 94 (manuscript received 1 Dec 93) pp 589-597

[Article by Ye. G. Olshevskiy, S.V. Lisakovskiy, T.V. Volodina, V.L. Kozeltsev, S.S. Shain, Scientific Research Center of Biological Structures, VILAR Scientific Production Association, Moscow; UDC 577.122]

[FBIS Abstract] Ergot sclerocial bodi es (Claviceps purpurea), which parasitize rye ears, are a valuable source of alkaloids, derivatives of lysergic acid. Alkaloids are widely used in pharmacology and medicine. One problem of cultivating thc fungus is that one must select strains with the needed alkaloids and identify them. However, the currently used method does not provide a preliminary evaluation of the state of the fungus genome, its stability, and possible alterations. The fraction composition of individual proteins can be used as an indirect indicator of the state of the genome, and this analysis can be obtained with two-dimensional O'Farrell electrophoresis. This method was used here to prepare a preliminary map of sclerocial body proteins of five ergot strains for subsequent comparison, identification, and evaluation of genome stability. The overwhelming majority of protein (polypeptide) fractions are identical for all five strains. A number (24) of variable fractions were found which can be used as strain markers. Individual protein maps, as well as a universal map for the five strains have been constructed. The total number of f ractions in the map is 616. This approach may be used to identify ergot strains and select new strains. Figures 3; table 1; references 15: 5 Russian, 10 Western.

Direct Antigen Detection in Immunoglobulin G Langmuir-Blodgett Films by Means of Surface Plasmon Resonance and in a Piezoelectric System.

957A0037A Moscow BIOKHIMIYA in Russian Vol 59 No 7 Jul 94 (manuscript received 02 Mar 94) pp 939-945

[Article by G.I. Lepesheva, I.V. Turko, I.A. Ges, and V.L. Chashehin, Institute of Bioorganic Chemistry, Belarus Academy of Sciences (first, second, and fourth authors) and Institute of Electronics, Belarus Academy of Sciences (third author)]

[FBIS Abstract] The direct recording of the antigen-antibody complex on Langmuir-Blodgett films of immunoglobulin G in unlabeled systems was investigated. The use of Langmuir-Blodgett technology for obtaining indicator phases of unlabeled immunosensors has two important advantages over other methods for immobilizing protein: the obtaining of multilayer structures and the achievement of maximum-density of packing of immobilizing IgG molecules.

Functional activity is the basic condition for using a solid phase with protein material immobilized on it as the sensitive surface (indicator phase) of a biosensor. In the case of IgG this most of all is the capability of reacting with the corresponding antibody.

The kinetics of the reaction of ferritin, the antigen, with LB films made of four IgG monolayers applied on hydrophobic silicon chips (0.5 x 1 cm) was studied. After two hours of incubation, the ratio of signal/noise comprised 13 percent; 50 percent binding of the antigen was achieved in 20 min. In experiments on the direct detection of the antigen by means of films, the incubation period was 30 min.

Calibration curves of the binding of ferritin with Langmuir- Blodgett films made of four monolayers of IgG on different supports were obtained in a range of antigen concentrations of 10^{-11}-10^{-9}. (a) and by silicon - a packing density of IgG in the monolayer of 7 nmol/cm^2. A direct correlation is found between the IgG packing density in the monolayer and the molar ratio of bound antigen: IgG of the top layer. Possibly the increase in the antigen-binding capability of films with a high IgG packing density in the monolayer is explained by their reaction with a large amount of epitopes of the multivalent antigen, ferritin.

The amount of antigen bound by IgG LB film on silicon and quartz supports does not depend on the number of monolayers. A somewhat smaller amount of antigen bound by LB films from one monolayer of IgG (about 10 percent) may be the result of the presence on the support surface of wrinkles or defects on the level of the thickness of the IgG monolayers.

A different picture is observed when an Ag surface support is used. In this case, the amount of bound antigen at first is very small and then increases, reaching a maximum in a six-monolayer films. Probably, this is due to the denaturing action on IgG of the high-energy metal surface. Removal of the active IgG layer from the silver surface by a distance of several monolayers leads to reduction in their antigen-binding capability. Establishing the relationship is very important from the standpoint of making direct optical systems for detecting the antigen-antibody reaction based on the method of surface plasma resonance. Application of IgG on a silver surface in the form of LB-films consisting of several monolayers makes it possible to use them as antibodies. This kind of a sensor system has a rather wide field of use.

IgG molecules in an LB-film retain their immunological activity, and this does not depend on the number of monolayers in the LB- film. An exception is the silver surface, where the denaturation of the active IgG layer may be prevented by an increase in the number of monolayers.

A model of a piezoelectric immunosensor is proposed. LB films of IgG are applied by the method of horizontal contact on the surface of a quartz resonator with an initial frequency of 3.3 MHz.

The maximal change in vibrational frequency of the quartz generator comprises 120 Hz; this is considered completely acceptable for sensors based on piezoelectric resonators. Consequently, LB-films of IgG can be used for direct recording of the antibody in a piezoelectric system.

Figures: 5; references: 1 Russian, 15 Western

Methylotropic Yeast Cells as a Biologically Active Material for Making Sensor Devices. I. Formaldehyde-Induced Acidification of the Medium and Its Biochemical Nature.

957A0037B Moscow BIOKHIMIYA in Russian Vol 59 No 7 Jul 94 (manuscript received 01 Dec 92; revised 22 Mar 94) pp 967-973

[Article by M.V. Gonchar, A.A. Sibirnyy, Department of Cell regulator Systems, Institute of Biochemistry, Ukraine Academy of Sciences, Y. I. Korpan, N.F. Starodreb, and A.V. Yelskaya, Institute of Molecular Biology and Genetics, Ukraine Academy of Sciences]

[FBIS Abstract] The biological characteristics of the liberation of H^+ induced by formaldehyde in wild and mutant strains of the methylotropic yeast *Hansenula polymorpha* were the subject of this study.

Incubation of wild type cells in an unbuffered aqueous solution of formaldehyde (15-35 mM) leads to rapid acidification of the suspension of cells. Acidification in the presence of 20 mM of formaldehyde yields a considerable amount of formate (0.6 mM at Ph 4.0). The acidification rate increases with an increase in the formaldehyde concentration to 25-35 mM but then decreases at higher concentrations. The region of saturation for

formaldehyde is considerably narrower than that for methanol-induced acidification. This difference, apparently, is due to the greater toxicity and chemical activity of formaldehyde.

The liberation of H^+ is characterized by a specific rate of 4.40 nmol H^+/min/mg of dried cells and depends on the physiological status of the cells as well as the strain used.

The effect of inhibitors of energy metabolism on the acidification process was studied. More than 80 percent is produced by NaN3, the inhibitor of mitochondrial enzymes—terminal oxidase and ATPase, and also antimycin. Incomplete reduction in the acidification rate is observed in the presence of a protonophor—3 chlorocarbonylcyanidphenythydrazine and the nonspecific ADPase inhibitor—dicyclohexylcarbodiimide.

The activity of methanol metabolism enzymes and the level of acidification of wild and mutant strains incubated in media with methanol, ethanol, glucose, or a mixture of formate with glycerol is reported. For all strains the absence of methanol-dependent acidification of cells grown on glucose or ethanol is explained by the complete repression of the first methanol metabolism enzyme—alcohol oxidase. Formaldehyde dehydrogenase also is confirmed by glucose and ethanol catabolite repression. A system of formaldehyde oxidation of the yeast is hypothesized.

It was expected that the introduction into strain 356 of a genetic block of formaldehyde reductase might accelerate the acidification process. In reality, the contrary result was obtained: there were both intensification and a reduction in the rate of acidification in the case of the A3 strain. Possibly the functioning of formaldehyde reductase *in vivo* is limited.

The growth of wild type cells on a mixture of glycerol (indifferent to the regulation of the methylotropic metabolism of the substrate) and formate (an inductor of the synthesis of methanol metabolism) also induces an oxidation system specific both to formaldehyde and methanol. At the same time, the mutant A-3-11 has a disturbed induction of alcohol dehydrogenase and formate dehydrogenase by formate but not by methanol; in the case of growth on a mixture of glycerol and formate only formaldehyde-dependent oxidation was observed.

The ratio of methanol and formaldehyde dependent oxidation in the A3-11 mutant inoculated in a medium with methanol are significantly higher than in the wild strain. This may be due to the incomplete induction of formate dehydrogenase in the A3-11 mutant. The specific rate of the formaldehyde-dependent liberation of H^+ by these cells is less than in the case of growth on methanol. This is not a trivial result, because it was expected that the disturbance of induction of formate dehydrogenase on a medium with glycerol and formate should cut off the requirement for formic acid and thus increase its liberation into the incubation medium.

If purposeful design of mutants with increased oxidation activity remains problematical, the obtaining of mutants with greater selectivity of oxidative response is completely realistic. Thus, cells of the mutant A3-11 inoculated on a medium with formate and glycerol liberate H^+ only in the presence of formaldehyde but not of methanol. Such an effect can also be achieved using natural phenomena for suppression of the activity of alcohol oxidase and formate dehydrogenase in wild type cells during growth on a medium with glucose or ethanol. Apparently both paths should be used in making sensors sensitive to formaldehyde which are based on pH-sensitive field transistors.

Figures: 2; tables: 3; references: Russian 6, Western 7.

Gel Model of Luciferase Functioning in the Cell

9570037C Moscow BIOKHIMIYA in Russian
Vol 59 No 7 Jul 94 (manuscript received 16 Feb 94)
pp 1020-1026

[Article by V.A. Kratasyuk, V.V. Abakumova, and N.B. Kim, Institute of Biophysics, Siberian Oblast, Russian Academy of Sciences]

[FBIS Abstract] Bioluminescent reactions catalyzed by luciferases, particularly bacterial enzymes, are especially promising for studying the mechanisms of energy transfer in different enzyme systems, because conversion of the chemical energy of luciferase into light takes place very efficiently. The purpose of this study was to develop a method for immobilizing luciferase in the bacterial cell.

Luciferase and NADH:FMN-oxidoreductase from *Photobacterium leiognathi* were immobilized in starch (cornstarch or partially hydrolyzed potato starch) gel and dried. The immobilized luciferase was obtained in the form of disks, the properties of which depended on the conditions used in preparing the reagent.

The optimal amount of gel necessary to obtain stable disks was 50-100 µl. The optimal drying time was 2-3 hours. The amount of activity of the enzyme depends on the characteristics of the initial luciferase preparation used, such as the purity of the preparation and its protein content. In all cases of the immobilization of purified enzymes, inactivation of luciferase decreased with an increase in the protein concentration. The increase in luciferase activity by immobilization in the gel can be explained by the close to optimal conditions reached, in which the reaction of luciferase with the enzyme-substrate is increased.

The immobilized reagent prepared from 100 µl of preparation immobilized in a starch gel of luciferase is a disk 7-8 mm in diameter, 50-60 microns thick, with a dry weight of 8.5-9.5 mg.

In the preparation of immobilized luciferase from hydrolyzed starch, the activity of the disks obtained increased with an increase in the activity of the original luciferase

solution taken for immobilization. The luciferase activity was higher in gels derived from unhydrolyzed cornstarch than that from hydrolyzed starch, probably because of changes in drying conditions.

With long drying, the support assumed importance. Lavsan (Dacron) film proved better than polyethylene, organic glass, cellophane, celluloid, parafilm, and cover glass. Disks obtained on a Lavsan support only after 25 uses lost it activity by 50 percent. Even after 50 determinations, more than 25 percent of the activity was retained. In addition, after drying, all the disks were easily detached from the Lavsan film and were uniform in size and activity.

Because inclusion in the gel did not provide a chemical bond between the matrix and the enzyme, the disk activity depended on the time of exposure in the solutions before the measurement of bioluminescence. When the exposure time was increased to 10 min., it activity increased, and in the interval from 10 min. to 2.5 hr. remained at practically the same level or fell slightly. After that, there was a sharp drop in activity. Therefore, in the measurements of bioluminescence, the disks were kept in the reaction mixture for 10 min. before initiation of the reaction by the addition of FMNH or NADH. Luciferase disks can be stored for more than one year at 22-25° without loss of activity.

Disks with a two-enzyme system (luciferase and NADH: FMN- oxidoreductase) can be used not less than 50 times.

The effect of different compounds added to the process of combined immobilization of luciferase and NADH:FMN-oxidoreductase was studied for dithiopeytol, FMN, tetradecanal, and NADH. The results show the possibility of the immobilization of complex metabolic chains of enzymes in starch gel.

The results show that the luciferase and the binary enzyme system NADH:FMN-oxidoreductase—luciferase is not inactivated, i.e., the functionally important enzyme groups are retained; this is confirmed by the high activity of the immobilized preparation. As the result of immobilization, the high specifity of luciferase with respect to aldehydes is retained.

For luciferase in a starch gel an optimal microenvironment is created which leads to an increase in the activity of the immobilized preparation in comparison with the solution taken for immobilization, in some cases by a factor of more than 3. Because of the stability of the enzyme in the solid vehicle, its stability increase. The enzyme included in the gel does not wash away but can be used repeatedly without loss of activity.

Tables: 7; references: Russian 2 Western 9.

Disturbance of the Monooxygenase System of the Liver by Perfluorocarbons in Vivo

957A0038A Moscow BIOKHIMIYA in Russian
Vol 59 No 8 Aug 94 (manuscript received 25 Jan 94)
pp 1175-118

[Article by V.V. Obraztsov, D.G. Shekhtman, and A.N. Sklifas, Institute of Cell Biophysics, Russian Academy of Sciences]

[FBIS Abstract] Oxidation-reduction reactions catalyzed by the monooxygenase system proceed according to the following reaction:

$NADPH + H^+ + O2 + XH = NADP^+ + XOH + H2O$

in which XH is the substrate, and XOH is the monooxygenase reaction product. However, the equation is valid for only several compounds. In most cases, less than 50 percent of the NADPH is consumed by the reduction of oxygen introduced into the substrate, and the rest goes for the reduction of oxygen to $O2^-$, H2O2, and H2O. In addition, known organic compounds, by forming an enzyme-substrate complex with cytochrome *P*-450 and by accelerating the oxidation of NADPH, can not include the active oxygen atom in their molecules as the result of their chemical inertness or steric hindrances. Such compounds, a typical member of which is perfluorohexane (PFH), are called microsomal oxidation uncouplers. Until recently they have been only of theoretical interest because introduction of PFH into an organism produce death as the result of a gas embolism. However, clinical use of blood substitute based on fluorocarbons not producing emboli but reacting with the microsomal cytochrome *P*-450 analogous to PFH posed the problem of the effect of fluorocarbons on microsome monooxygenase of the liver *in vivo*.

The purpose of this study was to find an answer to two questions: 1) whether uncoupling of the microsomal monooxygenase system takes place *in vivo* after introduction of the fluorocarbon emulsion, and 2) in the case of a positive finding, what physiological significance this process has.

A submicron emulsion of perfluorodecalin (PFD) and perfluoromethylcyclohexylpiperedine (PFMCP) was injected into male rats and rabbits, and the binding of microsomal cytochrome *P*-450 with fluorocarbons, and the rate of oxidation of NADPH by microsomes were determined on a spectrophotometer. The level of NADPH and NADH in the liver was determined by standard enzyme methods using lactate dehydrogenase and glutamate dehydrogenase. When the maximal content of the cytochrome *P*-450 was reached on the third day after injection of PFD in rats and the sixth day, in rabbits, the animals were denied food but had free access to water. Thus, the loss of weight of the animals would reflect the intensity of total metabolism.

When a PFD emulsion is injected into rats, the rate of oxidation of NADPH in liver microsomes reaches a level more than double that of the control and is observed on

the second day. Addition to these microsomes of an emulsion of PFMCP leads to a reverse spectrum of the binding of the cytochrome and a reduction in the rate of oxidation of NADPH.

However, the level of NADPH and NADH in the liver of rabbits remained unchanged after the injection of an emulsion of PFD.

The concentration of NADPH and NADH is an important parameter not only in monooxygenase reactions but also in various biosynthetic processes taking place in liver cells. To study this problem, the concentration of glucose in rabbit blood was measured; the glucose content remained practically unchanged for seven days. Apparently, the total rate of the requirement for NADPH in the monooxygenase system uncoupled by perfluorocarbons and in biosynthetic processes is considerably less than the rate of generation of NADPH in the normal organism with a constant intake of energy sources from without. However, under starvation conditions, animals treated with an emulsion of PFD lost weight slightly faster than the control animals, due to the energy dissipation in the fluorocarbon uncoupled monooxygenase reactions in the liver.

The slight increase in metabolism (by 16-17 percent) observed after introduction of the fluorocarbon emulsion was not unexpected. As a norm, only 9 percent of the oxygen absorbed by the animal participates in monooxygenase reactions. It is assumed that under the experimental conditions used that the proportion of oxygen required by the monooxygenase system increases. The monooxygenase system uncoupled by fluorocarbons generates primarily water, and not H2O2 and O2'. The changes in the isoform composition of the cytochrome *P*-450 in the liver of animals which received PFD is believed to bear a greater potential danger to the animal than the monooxygenase uncoupling reaction.

Furthermore, the uncoupling effect is small and local, and the use of fluorocarbons in medicine for lowering excess weight is not promising.

The monooxygenase uncoupling reactions after introduction of fluorocarbons is accompanied by an increase in the oxygen requirement of the animal; this has no relationship to the oxygen-transporting functions of fluorocarbon emulsions.

Figures: 4; tables: 2; reference: Russian 4, Western 8.

Participation of , , and Types of Opioid Receptors in Humoral Immune Response Regulation

957A0038B Moscow BIOKHIMIYA in Russian Vol 59 No 8 Aug 94 (manuscript received 21 Mar 94, revised 23 Apr 94), pp 1230- 1237

[Article by K.V. Dubinin, L.A. Zakharova, T.A. Alekseyev, L.A. Khegay, and S.V. Zaytsev, Chemical Enzymology Faculty, Chemistry Department, Moscow State University imeni M.V. Lomonosov (first, third, and fourth authors), Institute of Bioorganic Chemistry imeni M.M. Shemyakin and Yu. A. Ovchinnikov, Russian Academy of Sciences, Moscow (second author), and Karolinska Institutet, Endocrinology Faculty, Stockholm (fifth author).

[FBIS Abstract] Opioid receptors (OR) are of at least three types: μ, δ, and ε. The purpose of this work was to establish the correlation of changes in the total OR's, and also the distribution of these types with the dynamics of the development of the primary and secondary humoral response and to develop the functional role of different type of OR's in the regulation of antibody genesis.

The quantitative changes of OR in the dynamics of the development of the primary and secondary response to bovine γ-globulin (BGG) and the relationship of different OR types were studied in female mice by evaluating the level of the specific binding of 7 nM [^{3})of the primary and from 0 to the 9th day of the secondary response (inoculation 30 days later) to BGG.

After administration of the antigen *in vivo* an increase was observed in the level of specific opioid binding in lymph node cells, beginning with the first day of immunization. In the first immune response, the level of specific binding of [^{3}H] naloxone rose by a factor of almost 6 by the seventh day; this corresponds to the peak of the response to dissolved antigen. A plateau was maintained until the 14th day.

The participation of ε (ligand U69.593), μ (ligand DAGO) and δ (ligand DSLET) OR types in the development of the immune response by the inhibition of the binding of [^{3}H] naloxone by the corresponding ligands was studied. At the peak of the response (7th-8th day), the amount of ε type receptors rose by a factor of 5 in comparison to the initial phase of the response and comprised 63 percent of the total binding of the ligands of opioid receptors.

In contrast to the primary immune response, in the second response to BGG, the maximal level of the binding of ligands of opioid receptors to immunocompetent cells took place on the 5th day and increased by a factor of 1.5 over the initial level. The initial value was higher by a factor of 6 in comparison to the first immune response. The curve was bell-shaped until the 8th- 9th day, when it dropped. In the second immune response, the amount of ε-receptors increased, reaching its maximum on the second day, and then went down slightly. A correlation of the distribution was observed in the ratio of μ and δ receptors, the same as in the first response. Discrimination was not possible between the responses to these two types.

The specific binding of opioid ligands and the distribution by OR types changes over time, forming a classical kinetic dependence. An increase in the amount of ε receptors was accompanied by an increase in the amount of specific antibodies to BGG, and an increase in the amount of μ- and δ-receptors corresponded to it suppression.

In order to understand the role of different OR types in the regulation of antibody genesis, the action of selective ligands on the secretion of specific antibodies to BGG was studied. DAGO, DSLET, and U69.593 was added to a culture of lymph cells at the peak of the primary (7th day) and secondary (5th day) immune response in concentrations of 10^{-12}, 10^{-10} and 10^{-6} M. The effect was evaluated the next day. DAGO and DSLEt in a concentration of 10^{-6} M produced an antibody production of 17-28 percent for the first and second response. U69.593 in a concentration of 10^{-10}M had a stimulating effect, which comprised 48 percent during the primary and 12 percent during the second immune response.

The results obtained confirm the hypothesis of the participation of opoiods in paracrine and autocrine regulation of immunity. The development and retardation of humoral immune response may be controlled by an opiate energy system. Thus, on the 7th-14th day of the primary response, the specific binding of [^{3}H]naloxone increases considerably, and at the peak of the immune response receptors predominate which are sensitive to ε ligands, which possess a positive effect on antibody production. Then the amount of ε receptors decreases (to 2 percent on the 14th day), and the proportion of the inhibiting μ and δ receptor types increases, and this increase correlates with the drop in response to the antigen. In the second immunization, ε receptors predominate the whole time of the response, but the opioid binding has a maximum at the peak of the response. It is possible that at later stages of the secondary immune response, systems are involved which are different from opioid energy, because from the 5th to the 10th day, the distribution of receptor types changes insignificantly, but their concentration is reduced to the original.

Figures: 4; tables: 2; references: Russian 2, Western 19.

Modification by Exogenous Gangliosides of Biochemical Changes in Developing Cultures of Chick Embryonic Nerve Cells

957A0040A Moscow BIOKHIMIYA in Russian Vol 59 No 10 Oct 94 (manuscript received 25 Nov 93; revised 28 Apr 94) pp 1490-1496

[Article by V.B. Matyshichev, I.N. Sokolov, N.N. Nalivayeva, T.I. Safronova, S.A. Plesneva, and A.V. Zhaknov Physiology Research Institute imeni A.A. Ukhtomskiy, St. Petersburg State University (first, second, fourth, and sixth authors) and Institute of Evolutionary Physiology and Biochemistry imeni I.M. Sechenov, Russian Academy of Medical Sciences, St. Petersburg (third and fifth authors)]

[FBIS Abstract] Gangliosides play an important role in the regulation of growth and the differentiation of cells and in intercellular reactions of vertebrates, and they also possess neuritogenic and neurotropic effects. Disturbance of ganglioside metabolism leads to the development of pathology of the nervous system and a lethal outcome in early childhood growth. For a number of years glycosides have been used successfully as medicinal preparations for treating neuropathy of different etiologies. The effect of exogenous gangliosides on the change in the biochemical characteristics of a previously trypsinized mixed culture of chick embryo nerve cells during the growth and differentiation process was the subject of this study. Eleven-day old chick embryos were used.

In the course of the observation of the growth of a mixed culture of dissociated embryonic chick brain cells, the following phases of development were clearly observed: the formation of cell aggregates, the formation of cell layers, the appearance of nerve processes, and the steps of intensive synaptogenesis. About the 15th day of culturing, conglomerates of nerve cells with processes and neuroglia appeared. The appearance of neurons with processes, the establishment of axon-axon and axon-cell contacts, as a rule, was 2-3 days earlier in the experimental embryos than in the controls. From the 1st to the 15th day from the beginning of the experiment, the specific activity of acetylcholine cholinesterase (ACE) increased by a factor of 10, and of creatine (CK) kinase, by a factor of 17. The greatest effect was manifested on the 8th day of culturing, when the enzyme activity of the experimental embryos exceeded that of the control by a factor of 1.7 for CK and 4.5 for ACE.

The specific activity of adenylate cyclase (AC) up to the 8th day of development did not undergo substantial changes under the control conditions. The introduction of gangliocides into the culture medium is accompanied by an increase in the enzyme on the 8th day of the experiment. However, on the 1st day of culturing, i.e., the first 24 hours, no substantial increase in AC activity is observed, probably due to the lack of the necessary degree of maturity of the cells.

The phospholipid content doubled in 8 days in the control. In the presence of gangliosides, the phospholipid content in the experimental embryos was double that of the controls. The recording of great differences on the 8th day of development of the culture can be explained by the fact that in the presence of GM1 at this moment the functional effects of the enzymes first fully appear, while without the addition of GM1, the analogous stage is reached only on the 10th day of incubation of the nerve cells.

A higher protein content was observed on the 18th day of culturing cells with enzymes in the presence of gangliosides. In the control embryos this was observed on the 10th day. Probably, the increase in total protein content of the cell culture reflects a phase in intensive synthesis of protein related to the growth of axons and the formation of cell contacts.

Thus, ox brain ganglioside GM1 accelerates the growth and differentiation of cells in a culture of embryonic chick dissociated nerve tissue. This is a sensitive, available, and suitable model for the study of the neurotropic, neurotoxic, and neuroprotective effects of biologically active compounds.

Figures: 2; table 1; references: Russian 4 Western 15

ANSA-Analysis. I. Substrate Mixtures in the Analysis of Proteases. Characteristics of the Kinetics of Hydrolysis in the Presence of Competition

957A0040B Moscow BIOKHIMIYA in Russian Vol 59 No 10 Oct 94 (manuscript received 1 Mar 94; revised 12 Jun 94) pp 1511-1520

[Article by A.A. Nedospasov, A.P. Lifanov, and Ye. V. Rodina, Institute of Molecular Genetics, Russian Academy of Sciences, Moscow (first and third authors), Institute of Chemical Physics imeni N.N. Semenov, Russian Academy of Sciences, Moscow (second author), and Institute of Physicochemical Biology imeni A.N. Belozerskiy, Moscow State University (third author)]

[FBIS Abstract] ANSA is aminonaphthalene sulfonamide. ANSA analysis involves the use of mixtures of chromogenic substrates differing in detectable groups, with separate determination of the rearrangement products of each of the substrates. More than 30 USSR patents on this subject have been granted since 1989, and some of these are reviewed.

Example: A mixture contains substrate 1,2,3. Enzyme A splits substrates 1 and 2; enzyme B splits substrates 2 and 3. The substrate concentrations are comparable with *K*m. Consequently, substrates 1 and 2 are competing for enzyme A, and substrates 2 and 3 are competing for enzyme B. Substrates 1 and 3 are not competing for enzymes A and B; however, in the presence of substrate 2 in a mixture with, the splitting of each of them by "their own" enzyme will depend on the concentration of the other substrates. Such substrates are "dependent".

Calculations showed that as the best substrate is split off, its rate of splitting decreases, and the splitting of the other substrates increases, because the active center of the enzyme becomes accessible to the others. Thus, the kinetic curves for the remaining substrates have an S-shaped character. The maximal rate of splitting of the worst substrate may be greater than all the others. Theoretical curves and an experimental curve of data previously reported on the accumulation of ANSA products from the hydrolysis of a mixture of competing substrates by a commercial preparation of trypsin are presented.

In the case of noncompeting substrates, the family of kinetic curves will be a set of hyperbolas, i.e., the rate of splitting of each of them will constantly decrease.

If there is a mixture of several enzymes splitting a mixture of substrates, and at least one substrate is split by more than one enzyme, the group of competing substrates of each enzyme becomes independent. At low degrees of rearrangement, the picture does not change qualitatively, but at high concentrations a new effect appears. The simplest case is as follows: Enzyme A slowly splits substrates 1 and 2, and enzyme B rapidly splits substrate 3 and worse, substrate 2. After splitting of the greater part of 3, enzyme B begins to split 2 at a faster rate, and the total rate of splitting of this substrate by two enzymes is much faster than in the case of substrate 1 splitting only A.

Figures: 6; references: Russian 11, Western 22.

ANSA-Analysis. VI. Activation, Inhibition, and Interaction of Proteases in Enzyme Mixtures

957A0040C Moscow BIOKHIMIYA in Russian Vol 59 No 10 Oct 94 (manuscript received 1 Mar 94; revised 12 Jun 94) pp 1574-1588

[Article by A.V. Cherkasov, V.A. Nedospasov, A.D. Yakhimovich, and A.A. Nedospasov, Institute of Molecular Genetics, Russian Academy of Sciences, Moscow (all authors) and Institute of Atomic Energy imeni I.V. Kurchatov, Moscow (first author)]

[FBIS Abstract] ANSA-analysis is based on the cleavage by proteases of mixtures of competing chromogenic substrates containing aminonaphthalensulfonamide (ANSA) detectable groups. A chromatogram of the mixture of products (ANSA spectrum) proves to be a unique characteristic of the enzyme and can be used for identification, like a fingerprint. The ANSA spectrum of a mixture of several enzymes is equal to the sum of the ANSA spectra components in the same substrate mixture. If the number of substrates is not less than the number of enzymes in the mixture, and the ANSA spectra of each are known, it is possible to determine the quantitative composition of the mixture.

For the analysis of blood coagulation, mixtures of blood-clotting substrates were used. Hydrolysis of the substrate mixture catalyzed by blood samples gave characteristic chromatograms. Although the ANSA spectra do not make it possible to determine the protease composition of blood, they are informative. For example, one substrate may be split more effectively by thrombin than other substrates.

ANSA analysis is very useful for observing protease inhibitors. The literature on the use of ANSA for analysis of snake venom is critically reviewed. When an exogenous protease (trypsin) is introduced into the analytical sample, three cases are possible: 1) the venom contains no inhibitor; 2) the venom contains a free inhibitor; 3) the venom contains an inhibitor in a complex with the protease of the venom.

Commercial forms of dry snake venoms were screened for the presence of trypsin, thrombin, and chymotrypsin. The ANSA spectra of a mixture of venom-exogenous protease can be divided into four groups: 1) spectra which are close to additive; 2) complete inhibition of exogenous protease; 3) activation and inactivation of venom protease; 4) the appearance of new catalytic activities. The ANSA spectra of mixtures of trypsin and/or chymotrypsin with snake venom are described as A x (the ANSA spectrum of a protease) + B x (the ANSA spectrum of the venom) + C x (the ANSA spectrum of catalytic active interaction products). They are additive

(A=B=1, C=0), if no proteolysis, inhibition, or activation takes place. There are deviations from additivity for some mixtures of *Viperidae* (including *E. carinatus*, *Naja naja*, *Agkistrodon contortrix*, and *A. halys* venoms. Explanations are given for the inability to detect inhibitors in venoms having a high protease activity.

Figures: 2; tables: 5; references: Russian 9 Western 22.

'Color Vision' Receptor in Halobacterium Salinarium

957A0040D Moscow BIOKHIMIYA in Russian Vol 59 No 10 Oct 94 (manuscript received 18 May 94; revised 16 Jun 94) pp 1598-1607

[Article by R.N. Grishanin, S.I. Bibikov, A.D. Kaulen, and V.P. Skulachev, Institute of Physicochemical Biology imeni A.N. Belozerskiy, Moscow State University]

[FBIS Abstract] *Halobacterium salinarium* are lophotrichial archeobacteria which swim by means of bipolarly distributed bundles of flagella. The cells are propelled forward by one of the ends of the rod-shaped body. From time to time the linear movement is interrupted by spontaneous reversals, i.e., by a change of direction of approximately 180°. The reason for the reversal is the change in the direction of rotation of the flagella, which occurs randomly.

Phototaxis is a vitally important characteristic of the photosynthesizing cells of *H.salinarium*; it permits the finding of the optimal conditions of illumination for photosynthesis and vital activities, by avoiding the damaging action of ultraviolet light present in the spectrum of sunlight.

Retinal-containing proteins controlling the change in direction of the rotation of the flagella through a system of secondary messengers participate in the reception of changes in the intensity of light. An increase in the intensity of ultraviolet or blue light or a decrease in the intensity of red or orange light stimulates reversals in direction.

The photoreceptor system is based on the function of two components—the light-dependent generator, bacteriorhodopsin, and a previously unidentified receptor, the sensor rhodopsin. Blue light is received as a repellent through the M412 intermediate of the photocycle. The reaction is elicited by rapid drops in the potential difference on the bacterial membrane due to intermembrane proton translocation during the blue light induced conversion of the M412 intermediate into the bR568 form.

Figures: 5; Table: 2; References: Russian 1, Western 25.

New Site-Specific Endonuclease-Me thylase from Thermophilic Strain LU11 of Bacillus species

957A0041A Moscow BIOKHIMIYA in Russian Vol 59 No 11 Nov 94 (manuscript received 1 Jun 94; after revision 25 Jul 94) pp 1714-1729

[Article by A. V. Chernov, N. N. Matviyenko, L. A. Zheleznaya, N. I. Matviyenko, Institute of P roteins, Branch of M. M. Shemyakin and Yu. A. Ovchinnikov Institute of Bio-Organic Chemistry, Institute of Theoretical and Experimental Biophysics, Russian Academy of Sciences, Pushchino, Moscow Oblast; UDC 577.152.314'1]

[FBIS Abstract] A new site-specific endonuclease, BspLU11III, is isolated and purified to a homogeneous state from a thermophilic strain of Bacillus species LU11. BspLU1III does not belong to any of the three known classes of endonucleases, but is close in its properties to the IV type of site-specific endonucleases. The enzyme recognizes the sequence 5'-GGGAC-3' in double-stranded DNA and clea ves it in two places at a distance of 10 and 11 nucleotides from the 3' end of e 5'-GGGAC-3' sequence, and at distances of 14 and 15 nucleotides form the recognized site along the complementary strand. The enzyme exists in solution in the form of a monomer with a molecular mass of about 93 kDa. When S-adenosyl-L-methionine (SAM) is present, the enzyme manifests methylase a ctivity. The adenine residue is methylated within the recognition site of 5'-GGGA*C-3' along one of the DNA chains. The restriction activity of BspLU11III is independent of ATP and is stimulated by a SAM concentration of 80 μM. Magnesium ions are needed to manifest the restriction activity. When chlorine ions are present "star" activity is observed. BspLU 11III is similar to Eco57I. Figures 13; table 1; references 20: 4 Russian, 16 Western.

New Site-Specific Endonuclease-Methylase from a Thermophilic Strain of Bacillus species KT6

957A0041B Moscow BIOKHIMIYA in Russian Vol 59 No 11 Nov 94 (manuscript received 1 Jun 94; after revision 29 Jul 94) pp 1730-1738

[Article by N. I. Shapovalova, L. A. Zheleznaya, N. I. Matviyenko, Institute of Proteins, Institute of Theoretical and Experimental Biophysics, Russian Academy of Sciences, Pushchino, Moscow Oblast; UDC 577.152]

[FBIS Abstract] A site-specific endonuclease R. BspKT6I was purified to a functionally pure state from a thermophilic strain of Bacillus species KT6. This endonuclease is the first representative of a new subgroup of isoschizomers which rcognize the sequence GATC. The enzyme was obtained through gel filtration on Sephadex G100 and successive chromatography on heparin-Sep harose and hydroxyapatite. A cognate site-specific methylase M. BspKT6I was also purified. BspKT6I is an isomer but not an isoschizomer of the endonucleases Sau3AI and MboI. It recognizes the sequence GATC in the DNA molecule and cleaves it between the T and C. In contrast to Sau3AI and MboI, this endonuclease forms 3'-protruding dinucleotides. Cleaving of the site is inhibited by dam-methylation. The sticky ends formed by BspKT6I are identical and complementary to the ends formed by endonuc lease PvuI. The methylase isolated from the Bacillus species KT6 strain protects DNA from subsequent cleaving by BspKT6I. A denine is the methylated base. Figures 9; table 1; references 19: 3 Russian, 16 Western.

Ce-137, Sr-90, and Microelement Content in Breast Milk of Women from Regions of Belarus Contaminated with Radionuclides

957A0043A Minsk ZDRAVOOKHRANENIYE BELARUSI in Russian No 12 Dec 94 (manuscript received 25 Apr 94) pp 30-33

[Article by V. K. Zubovich, A. K. Ustinovich, V. Yu. Dombrovskiy, A. M. I skritskiy, G. A. Petrov, A. N. Shilko, V. N. Zemskov, S. A. Shreder, Belarusan Scientific Research Institute for Protection of Mothers and Children, Institute of Radiobiology, Academy of Sciences, Republic of Belarus; UDC 613.287.1: 614.73(476)]

[FBIS Abstract] This studied determined the cesium-137, strontium-90, lead, copper, iron, magnesium, and zinc content of breast milk from women in contaminated and "clean" regions of Belarus. It was found that the "clean" region had been exposed to radioactive contamination of agricultural products, and because the area was considered clean, no radiation precautions were taken. Cesium was found in all samples, but only 2.3% of samples from the polluted regions had a cesium content which exceede d the republic permissible level established in 1992. All samples also contained strontium, and a total of 22.3% of the sam ples had a strontium content significantly exceeding the permissible level. In all regions the lead content was many times higher than the WHO standard, and was especially high in the breast milk of women from polluted regions. Copper and magnesium content was within WHO limits. Iron and zinc levels exceeded WHO limits. An organization must be established to monitor radi onuclide levels in breast milk; it is the only food product that is not monitored. Table 1; references 12: 3 Russian, 9 West ern.

Long-Term Consequences of Exposure to Ionizing Radiation on Hemopoiesis in Adults Evacuated from the 30-km Chernobyl Zone

957A0043B Minsk ZDRAVOOKHRANENIYE BELARUSI in Russian No 12 Dec 94 (manuscript received 12 May 94) pp 33-37

[Article by Ya. S. Miksha, I. P. Danilov, V. A. Rzhentskiy, Scientific Rese arch Institute of Hematology and Blood Transfusion, Ministry of Health, Republic of Belarus; UDC 612.014.482:612.119]

[FBIS Abstract] In the 5-7 years since the Chernobyl accident, 18 parameters of the morphological content of peripheral blood h ave been studied. The study consisted of 748 adults in the study who were evacuated from the 30-km Chernobyl zone, and 1098 adults form clean zones. The subjects in both groups were aged 15-60. There was no substantial difference in the average val ues of indicators of morphological content of peripheral blood between the experimental or control groups. Statistical analy sis of qualitative indicators revealed the prevalence of moderate monocytopenia ($0.11x10^9$/l to $0.15x10^9$/l) in individuals evacuated from the 30 km zone (8.2-12.8%). Despite the massive full-spectrum effect of radionuclides, long-term effects on the hemopoiesis system of evacuated individuals are minimal, consisting of a moderate immunological disb alance. There is no basis for blaming anemia on radiation exposure, because it is found equally in the experimental and control groups. Tables 2; reference 1 (Russian).

Status and Trends of Child Mortality in Belarus Republic

957A0044A Minsk ZDRAVOOKHRANENIYE BELARUSI in Russian No 12 Dec 94 (manuscript received 19 Apr 94) pp 40-43

[Article by I. B. Dzikovich and I. P. Bogdanovich, Belarus Research Institute of Mother and Child Care; UDC 616-053.2-036.88(476)]

[FBIS Translated Text] *Abstract.* Systems and structural analysis was made of quantitative indicators of child mortality in 1988-1993 in Belarus. The obtained data permitted evaluation of changes in the structure of child mortality that have occurred over these 6 years, with consideration of age, sex, and place of residence. Tables 2.

Key words: child mortality, systems and structural analysis, indicators, causes of death.

Infant mortality, i.e., mortality in the first year of life, has always been in the center of attention, not only of health care agencies, but also the entire government, since this is an integrated indicator characterizing not only the condition of health care, but also level of social, economic and health-related well-being of society. At the same time, in medical-demographic and sociological studies, the indicators and structure of child mortality (mortality among children 0-14 years of age) were given unjustifiably little attention. It is believed that a high or rising level of child mortality, as well as its stability with increase in per capita income, are indicative of shortcomings in the process of development of a given country. WHO notes that judicious distribution of available resources would enable each country to lower child mortality by 50 percent by the year 2000.

In view of the foregoing, in this report we are offering a more detailed analysis of age-related structure and causes of death among children over 1 year old. In this analysis, we used data from national statistics on causes of child mortality in 1988-1993, which were provided by the Belarus State Committee for Statistics and Analysis. The indicators of child mortality were determined as follows: the number of deaths among children 0 to 14 years old was multiplied by 1000 and divided by the mean annual child population up to the age of 14.

According to the results, our republic is among the regions with a low child mortality indicator, and it constituted 1.5/1000 children in 1988, corresponding to 3404 cases of child death. Over the 6 years covered by

our analysis, we observed a stable trend toward decline of this indicator, to 1.0/1000 children or 2466 cases in 1993. According to WHO recommendations, contained in the International Classification of Diseases (9th and 10th revisions), one must analyze standardized indicators, i.e., indicators as a function of age and sex of the population group studied.

For this reason, we studied the structure of cases of child deaths in the following gradation: 0-12 months, 1-4, 5-9, and 10-14 years, as well as in relation to the child's sex and place of resident (city or village).

The age structure of child mortality and its dynamics are reflected in Table 1.

Table 1. Dynamics of age structure of child mortality in Belarus

Age	Year					
	1988	1989	1990	1991	1992	1993
0-14 years	3404.0*	3020.0	2812.0	2814.0	2677.0	2466.0
	100.0	100.0	100.0	100.0	100.0	100.0
0-12 months	2144.0	1835.0	1717.0	1616.0	1584.0	1487.0
	63.0	60.8	61.1	57.4	59.2	60.3
1-4 years	633.0	531.0	530.0	520.0	464.0	414.0
	18.6	17.6	18.8	18.5	17.3	16.8
5-9 years	336.0	357.0	312.0	376.0	331.0	288.0
	9.9	11.8	11.1	13.4	12.4	11.7
10-14 years	291.0	297.0	253.0	302.0	248.0	277.0
	8.5	9.8	9.0	10.7	11.1	11.2
Totals per 1000 child population	1.5	1.3	1.2	1.2	1.1	1.0

*Here and in Table 2 the first [of each two lines] gives absolute number and the second, percentage.

According to this table, more than half the cases of child deaths occur in the first year of life (63.0 percent in 1988, 60.3 percent in 1993). During the period analyzed, there was a tendency toward decline in share of this age group in child mortality.

The age of 1 to 4 years was found to be in second place in the structure of child mortality, with an 18.8 percent share of all cases of child death. In the last 6 years, the share for this age group also presented a tendency toward decline.

The group for children 5 to 9 years of age accounted for 9.9 to 13.4 percent of all child deaths in this republic. We noted a rise in share of deaths for this age group to 13.4 percent in 1991, followed by a decline to 11.7 percent in 1993.

Virtually the same share was found to prevail for deaths among children over 9 years old, and it showed a 1.3-fold rise from 1988 to 1993.

Analysis of child mortality in relation to place of residence revealed that more than 60 percent of the deaths at age 0-14 years occurred among urban residents, and this applied to all age groups. Among urban residents, the largest share was found among infants up to 1 year old (66.4 percent in 1988, 65.6 percent in 1993), and the smallest, among those 1-4 years of age (51.7 percent in 1988, 55.6 percent in 1993).

Boys constituted 60-61 percent and girls 39-40 percent among deaths at 0-14 years, and this relationship was stable throughout the period studied and in all age groups.

For analysis of causes of child mortality we used the eight chief causes according to the International Classification of Diseases (9th revision). In essence, the group of "other causes" consisted of different states occurring in the perinatal period which were the chief cause of death among infants up to 1 year old and, for this reason, they were excluded in our analysis of causes of death among children over 1 year old. Our findings are listed in Table 2.

Table 2. Structure of chief causes of child death at 0-14 years of age (1988-1993)

Cause	Age									
	0-14 years		0-12 months		1-4 years		5-9 years		10-14 years	
	1988	1993	1988	1993	1988	1993	1988	1993	1988	1993
Infectious and parasitic diseases	241.0	184.0	178.0	157.0	50.0	22.0	8.0	2.0	5.0	3.0
	7.1	7.5	8.3	10.6	7.9	5.3	2.4	0.7	1.7	1.1
Neoplasms	217.0	141.0	17.0	13.0	84.0	44.0	68.0	35.0	48.0	49.0
	6.4	5.7	0.8	0.9	13.2	10.6	20.2	12.2	16.5	17.7
Sense organ and nervous system diseases	176.0	138.0	50.0	30.0	58.0	35.0	40.0	38.0	28.0	35.0
	5.2	5.6	2.3	2.0	9.2	8.5	11.9	13.2	9.6	12.6
Circulatory system diseases	34.0	5.0	10.0	2.0	10.0	1.0	4.0	—	10.0	2.0
	1.0	0.2	0.5	0.1	1.6	0.2	1.2	—	3.4	0.7
Respiratory organ diseases	496.0	276.0	382.0	224.0	98.0	32.0	12.0	11.0	4.0	9.0
	14.6	11.2	17.8	15.1	15.5	7.7	3.6	3.8	1.4	3.2
Digestive organ diseases	46.0	17.0	25.0	9.0	12.0	3.0	3.0	3.0	6.0	2.0
	1.4	0.7	1.2	0.6	1.9	0.7	0.9	1.0	2.1	0.7
Congenital developmental defects	795.0	563.0	672.0	451.0	89.0	76.0	20.0	20.0	14.0	16.0
	23.3	22.8	31.3	30.3	14.1	18.4	5.9	6.9	4.8	5.8
Trauma, accidents, poisoning	607.0	531.0	69.0	49.0	213.0	181.0	168.0	159.0	157.0	142.0
	17.8	21.5	3.2	3.3	33.6	43.7	50.0	55.2	54.0	51.3
Other diseases	792.0	611.0	741.0	552.0	19.0	20.0	13.0	20.0	19.0	19.0
	23.2	24.8	34.6	37.1	3.0	4.8	3.9	6.9	6.5	6.9
Totals	3404.0	2466.0	2144.0	1487.0	633.0	414.0	336.0	288.0	291.0	277.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Congenital developmental defects were in first place in the structure of child mortality; they were the cause of death in almost every fourth case of death at up to 14 years of age. The age structure indicates that more than 80 percent of the children who died of congenital developmental defects did not survive to 1 year of age, and this cause, as well as different states arising in the perinatal period, essentially determine infant mortality. It should be noted that about half of the remaining 20 percent of the children who died of congenital developmental defects did so at 1 to 4 years of age. Among the developmental defects there is prevalence of abnormalities of the cardiovascular system, as well as spina bifida and congenital hydrocephalus.

Trauma, accidents and poisoning are in second place as causes in the structure of child mortality, and are steadily rising. They were the cause of death of every fifth child. However, one should pay attention to the fact that, even in the 1-4-year group, they become the prime cause: it accounted for 30-40 percent of the deaths of children of this age, and more than 50 percent of children over 5 years old.

Respiratory diseases were in third place in the structure of causes of child mortality, and their share dropped by 1.8 times over the 6-year period analyzed. In this class of diseases, pneumonia was most prominent, accounting for more than half of all respiratory diseases. There are some age-related differences in incidence of this pathology: respiratory diseases are the second cause of death among infants up to 1 year old and form 1 to 4 years old. In both groups, there was a decline in share of mortality due to respiratory diseases, more marked in the latter group.

The next cause of child mortality was infectious and parasitic pathology. In 1993, the absolute number of deaths from this cause was 1.3 times lower than in 1988. Typically, up to 95 percent of all deaths from infectious pathology was referable to children in the first 5 years of life (0-1 and 1-4 year groups). The decline in share of this

pathology observed in the last 6 years occurred mainly due to decline in lethal outcome among children 1-4 years old (by 1.5 times) and 5-9 years old (by 3.4 times).

Deaths due to neoplasms (more than 90 percent were malignant, with prevalence of leukemia and lymphoid tissue neoplasms) were in fifth place in the structure of child mortality; the share of this pathology was stable for 5 years, with some decline in 1993. The main age period is from 1 to 4 and 5 to 9 years (36-39 percent and 31-34 percent, respectively, of all deaths of children with this diagnosis in 1988-1992).

In 5 percent of the cases, diseases of the nervous system and sense organs were the cause of child death; this figure has been stable in our republic for the last few years. More than one third of the deaths from this cause was referable to children in the 1-4-year group.

In the older 10-14-year group, diseases of the circulatory system were in fifth place in the structure of causes of death, and in expressly this age group the share of such diseases was highest in 1988. The absolute number of child deaths from these diseases dropped to one-half in 6 years, and the decline was noted in all age groups. There was also a decline to one-half in child deaths due to digestive organ diseases.

If we consider the sex difference in the structure of child mortality, we can note that there was a higher share of girls among deaths due to infectious and parasitic pathology, diseases of the nervous system and sense organs. The share of boys was higher among deaths due to malignant neoplasms and resulting from trauma, accidents and poisoning.

There were also some differences between mortality indicators of children residing in urban and rural areas. Thus, among rural children, there was a higher share of deaths from intestinal infections, anemia, respiratory, nervous system and sense organ diseases. Urban children died more often than rural ones due to septicemia, neoplasms, and congenital developmental defects.

Thus, our analysis revealed some relationship between morbidity, cause of death and a child's age, as well as sex and place of residence, which shows that it is imperative to take this into consideration both when organizing medical care for children and developing social, pedagogic and other programs related to the child population. However, the existing departmental accounting and record-keeping forms concerning work with the child population cannot provide the necessary information to health care organizers and practicing physicians. This means that they must be changed and new reporting forms must be adopted, which would take into consideration the distinctive features in morbidity and mortality of the child population, as related to age, sex and residence, and this is consistent with WHO requirements for such documentation.

Identified Genes of Plant Resistance to Disease and Possible Practical Applications

957A0046A Moscow GENETIKA in Russian
Vol 30 No 10 Oct 94 (manuscript received 10 Mar 94)
pp 1334-1342

[Article by V.I. Krivchenko, Vavilov All-Russian Scientific Research Institute of Plant Industry; UDC 575:631.524.86.01:632.1/4]

[FBIS Abstract] Genetic diversity, expressed as various levels of specific and nonspecific resistance, determines the stability of ecosystems of plants subject to biotic stress, in particular, monocultures. All existing projects to select for resistance to infectious diseases are based on the use of the genetic material responsible for this trait. The specific example of wheat genes resis tant to powdery mildew is presented. Tables of genes which control plant resistance to infectious disease have been compiled.

Analysis of the resistance genes in 1200 varieties of several grains indicates that many are identical. This reduces variety in the gene pool; however, the pool has sufficient resources to reduce the rate of pathogen adaptation. In the last 15 years, the institute has identified about 30 new effective genes for resistance to phytopathogens in wheat, barley, and rye. These genes are not recorded in international registries. The gene pool of cultured and wild related forms are sources of new genes. Wild plants have the highest immunological potential. To increase genetic diversity in terms of resistance, varieties of plants cultivated locally have been analyzed, in particular, varieties of barley resistant to powdery mildew. These varieties were in some cases developed by local farmers. These varieties were previously considered ineffective; however now they are being reexamined. These cultivars are frequently heterogeneous mixtures of lines, and thus are promising. Tables 5; refe rences 31: 19 Russian, 12 Western.

Regeneration Genetics in Grain in vitro Culture

957A0046B Moscow GENETIKA in Russian
Vol 30 No 10 Oct 94 (manuscript received 10 Mar 94)
pp 1432-1440

[Article by O.G. Kozyreva, S.Ye. Dunayeva, Vavilov All-Russian Scientific Research Institute of Plant Industry, St. Petersburg; UDC 575.76:582.542.1]

[FBIS Abstract] Basic research trends in the genetics of regeneration of grain cultures in vitro are presented. Attention is focused on intraspecific variability, genetic determination of regeneration traits, and the participation of individual chromosomes and genes in the process. The authors' experimental data are presented on varieties and dihaploid lines of barley which indicate the dominance of a high re generation capacity (sprout formation) in a callus culture of immature hybrid embryos, the interaction of nuclear and cytopla smic determinants in genetic determination of the trait, and the possibility of isolating genotypes which differ by one

gene. Methods using the genetics of quantitative traits in grains have shown a predominantly additive polygenic effect in the control of in vitro regeneration capacity trait. Key genes with a strong regenerative effect have been located. A correlation w as found between the rate of development of the embryo and the length of the vegetative period of the plant. It is necessary to consider ontogenetic control of the regeneration capacity trait when analyzing inheritance in F_1 and F_2 when crossing lines differing in their development rates. Figure 1; tables 3; references 57: 12 Russian, 45 Western.

Cellulolytic, Xylanolytic, and Lignolytic Enzymes of the Fungus Pleurotus ostreatus

957A0048A Moscow PRIKLADNAYA BIOKHIMIYA I MIKROBIOLOGIYA in Russian Vol 30 No 1 Jan-Feb 94 (manuscript received 22 Apr 92) pp 42-48

[Article by Z. R. Akhmedova, Institute of Biochemistry and Physiology of Microorganisms, Russian Academy of Sciences, Pushchino; UDC 577.152: 22+577.154.33+582.282]

[FBIS Abstract] Basidiomycetes are a promising source of cellulolytic, xylanolytic, and lignolytic enzymes because of their powerful hydrolytic and oxidizing activity, their rapid growth rate, and ability to penetrate impenetrable substrates. Their ability to produce enzymes depends on the available nutrients, cultivation conditions, and features of the strain. The ability of the basidiomycete Pleurotus ostreatus to degrade wood is studied. Extracellular cellulolytic, xylanolytic, and lignolytic enzymes are formed when the fungus is cultured in submerged media containing vegetable wastes (depleted bagasse of cotton seed, ground oilcake, cotton stems, rice hulls, and hemp-mallow scutch). The enzymes formed are endogluconade, cellobiase (cellulolytic), xylanase (xylanolytic), peroxidase, and laccase (lignolytic). The biosynthesis of enzymes depends on the composition and structure of the vegetable substrate in the nutritive medium and the cultivation time. The enzymatic complexes secreted by P. ostreatus could utilize 30-70% of the wastes of the timber industry. Figures 2; tables 2; references 36: 16 Russian, 20 Western.

Mutagenesis of a Styrene-Degrading Strain of Pseudomonas sp. Y2: Analysis of Transformation Products and DNA Study of Mutants

957A0048B Moscow PRIKLADNAYA BIOKHIMIYA I MIKROBIOLOGIYA in Russian Vol 30 No 1 Jan-Feb 94 (manuscript received 12 Oct 92) pp 55-63

[Article by M.M. Yakimov, I.S. Rogozhin, E. Calderon F., L.N. Matveyeva, G. I. Karavaytseva, A.M. Bezborodov, Ye.I. Rogayev, Bach Institute of Biochemistry, Russian Academy of Sciences, Moscow, Institute of Psychiatry, Russian Academy of Medical Sciences, Moscow; UDC 5 79.841.11]

[FBIS Abstract] Bacterial cells of Pseudomonas sp. Y2 capable of using styrene as the sole source of carbon and energy were subjected to Tn5 (Km^r) mutagenesis. The mutants were divided into classes by their ability to grow on styrene, 2-phenylethanol, and phenylacetate. Styrene can be degraded by oxidizing the side chain or by direct oxidation of the aromatic ring. In Pseudomonas sp. Y2 styrene can be degraded by oxidation of the side chain in two ways. In one of the ways, 2-phenylethanol is not an intermediate metabolite. To compare the strains and to determine genetic markers, the complete DNA of the strains was studied using electrophoresis of restriction fragments with subsequent blot hybridization with marked DNA probes. All Tn5 mutants were found to be very similar to the parent strain. It is believed that the transposon on Tn5 activates the plasmid or chromo- [illegible] al path of oxidation of styrene, activating oxidation of [illegible] side chain. Figures 5; table 1; references 24: 4 [illegible] 20 Western.

[illegible]on of Silver Cyanide Complex by Ps[illegible]as Fluorescens Culture

957A0048C Moscow PRIKLADNAYA BIOKHIMIYA I MIKROBIOLOGIYA in Russian Vol 30 No 1 Jan-Feb 94 (manuscript received 24 Jun 92) pp 73-77

[Article by V.I. Podolskaya, Z.R. Ulberg, V.E. Shpak, N.I. Grishchenko, L.N. Yakubenko, Institute of Biocolloidal Chemistry, Academy of Sciences of Ukraine, Kiev; UDC 628.543]

[FBIS Abstract] This paper studies the kinetics of the decomposition of silver cyanide complex by Pseudomonas fluorescens VKM B-5040, which decreases the amount of cyanide and silver ions in solution. This experiment was conducted under conditions of periodic cell cultivation. Optimal conditions were determined. The maximum rate of decomposition of the complex salt was observed during growth in media containing calcium ions, bivalent iron, or a yeast extract. THe maximum rate of destruction of CN-ions from solutions of complex anions $Ag(CN)_2$ was 16.7 mg/day. There was a decrease in pH by several units when $NaAg(CN)_2$ was introduced to the culture. The bactericidal effect of silver must be considered, however. P. fluorescens can not only grow in the presence of silver compounds, but it can also absorb large quantities of them. The higher the concentration of biomass in the solution, the more effective the accumulation of silver by the cells. A correlation was found between the electrokinetic potential of ht cells and the decomposition kinetics of the complex cyan ide. The strain studied here may be used to destroy cyanides in waste waters containing heavy metal-cyanide compounds. Figu res 5; references 11: 9 Russian, 2 Western.

Cloning of the Bromperoxidase Gene from Pseudomonas aureofaciens

957A0048D Moscow PRIKLADNAYA BIOKHIMIYA I MIKROBIOLOGIYA in Russian Vol 30 No 1 Jan-Feb 94 (manuscript received 21 May 92) pp 78-82

[Article by V.N. Burd, K.H. Van Pee, F. Lingens, A.I. Voskoboyev, Grodno State University, Belarus, Institut für Mikrobiologie der Universität Hohenheim, Stuttgart; UDC 577.214:577.158]

[FBIS Abstract] In the presence of bromide ions, Pseudomonas aureofaciens ATCC43051 forms derivatives which contain bromine atoms. This paper searches for the gene which produces the enzyme responsible fo this transformation and clones them to obtain a mutant capable of synthesizing this enzyme. Blot-hybridization was used to find fragments of chromosomal DNA of Pseudomonas aureofaciens cells with a localized bromperoxidase gene. The DNA fragments, which were 10,000, 7000, and 4400 nucleotides long, were cloned in E. coli TG2 using pUG18, with repeated cloning of the 4400 nucleotide DNA fragment in Streptomyces lividans using promoter probe vector pIJ 486. Cloning of the bromperoxidase gene from P. aureofaciens did not yield a superproducer of the desired enzyme. The DNA fragments used were sufficiently long to contain the gene. New target cells which offer a high level of gene expression must be found for the gene to be cloned. The possibility that the full-scale gene was destroyed in processing of the chromosomal DNA by endonucleases has not been ruled out. Figures 3; references 14 (Western).

Comparative Study of the Effect of Microbial Inhibitors on Various -glucosidases

957A0048E Moscow PRIKLADNAYA BIOKHIMIYA I MIKROBIOLOGIYA in Russian Vol 30 No 1 Jan-Feb 94 (manuscript received 18 Jun 92) pp 83-87

[Article by N.Yu. Akulova, G.A.Kazanina, A.A. Selezneva, State Scientific Research Technological Institute of Antibiotics and Enzymes for Medical Applications, St. Petersburg, UDC 577. 151]

[FBIS Abstract] Medicines are being sought which slow carbohydrate metabolism using microbial inhibitors of α-glu cosidase. The authors have isolated a new biologically active substance which has an inhibiting effect on α-glucosidases of various origins. Comparison of the physico-chemical and biochemical properties of the new inhibitor and Acarbose, an existing inhibitor, shows that the new inhibitor derived from Streptomyces sp. is more selective, suppresses hydrolysis of high-molecular substrates of pancreatic α-amylase and sacharase, and at the same pH stability has a higher molecular mass (2100+/-100) than Acarbose. The new inhibitor is also highly resistant to the effect of temperature. The suppressive effect of the inhibitors on glucosidases differs, and the effect of the inhibitors on individual glucosidases of the small intestine mucosa must be studied. At certain concentrations, these inhibitors may be used as substrates for a complex of intestinal glucosida ses It may be possible to use the Streptomyces sp. inhibitor as a regulator, in conjunction with diet, of various disruptio ns of carbohydrate metabolism. Figures 3; tables 2; references 12: 6 Russian, 6 Western.

Adsorption of Lead Ions by Aspergillus niger. Effect of Mycelium Pretreatment

957A0048F Moscow PRIKLADNAYA BIOKHIMIYA I MIKROBIOLOGIYA in Russian Vol 30 No 1 Jan-Feb 94 (manuscript received 22 Apr 92) pp 149-155

[Article by Ye. P. Feofilova, A.P. Marin, V.M. Tereshina, Institute of Microbiology, Russian Academy of Sciences, Moscow; UDC 582.282.4.66.081.3]

[FBIS Abstract] The relation between the chemical composition of the mycelium Aspergillus niger and its ability to adsorb lead ions is established. Adsorption is aided by removal of surface lipids (primarily saturated hydrocarbons and waxes), destruction of the lipid bilayer, and displacement and rearrangement of the cell biopolymers. This causes the surface to become grainy. Processing of the mycelium with an alkali, which removes compounds containing mainly phosphate and COOH groups, did not improve adsorption of lead ions by A spergillus niger. Removal of water-soluble substances substantially reduced its adsorbing capacity. A table illustrates the effect of various types of processing of A. niger on lead ion adsorption. A molecular model of adsorption is suggested which considers specific properties of chitin and chitosan, the main biopolymers of the fungus, and their amorphous and crystalline qualities. Adsorption involves not only the biopolymers, but also other substances making up the cell wall matrix. It is found that adsorption depends on the properties of the ion being adsorbed, and this in turn, plays a role in determining the type of pretreatment. Figures 3; tables 2; references 12. 4 Russian, 8 Western.

Use of Neodymium Laser for Fluorescent Diagnosis and Photodynamic Destruction of Tumor

957A0051A Moscow BIOFIZIKA in Russian Vol 39 No 6 Nov-Dec 94 (manuscript received 10 Dec 92) pp 1063-1065

[Article by V.A. Oganesyan, A.S. Seylanov and Yu.A. Seylanova, Lazernaya tekhnika Scientific Production Association, Yerevan; Medical Radiology Scientific Research Institute, Armenian Health Ministry, Yerevan]

[FBIS Abstract] A study was made of the fluorescence spectra and photodynamic destruction of tumorous tissues containing the derivative hematoporphyrin by the generation of the second and third harmonics of a YA:Nd^{3+} solid-state laser rather than gas- or liquid-type lasers. This laser had been used earlier by the authors in treating Ehrlich's ascitic carcinoma. This nanosecond laser with electrooptic quality modulation has now been

used in studying the spectroluminescent characteristics of tissues of rats with sarcoma 45 employing a multistrand light conductor and a monochromator-photomultiplier- microcomputer complex. A hematoporphyrin derivative was used as the photosensitizer; it was injected in a concentration 10 mg per kilogram of body weight. One group of animals did not receive this derivative and served as a control group. Comparison of the two groups indicated a high efficacy of the method. The use of the described solid-state yttrium aluminate-neodymium laser facilitates detection of the spectral characteristics of luminescence of tumorous tissue in a broad spectral range and enhances the efficacy of fluorescent analysis. An automated system developed on the basis of such a laser, operating at wavelengths 360 and 540 nm, can be used for in vivo diagnosis, photodynamic treatment of tumors using tumorotropic dyes and also for determining the kinetics of distribution and accumulation of the latter in the body. Figures 2; references 3: 2 Russian, 1 Western.

New Possibilities for Estimating Radiation Dose Absorption by Electron Spin Resonance Method

957A0051B Moscow BIOFIZIKA in Russian Vol 39 No 6 Nov-Dec 94 (manuscript received 27 Sep 93) pp 1075-1081

[Article by I.A. Moroz, V.A. Serezhenkov, G.A. Klevezal, D.Sh. Burbayev and A. F. Vanin, Chemical Physics Institute imeni N. N. Semenov, Russian Academy of Sciences; Biology of Development Institute, Russian Academy of Sciences]

[FBIS Abstract] It has been demonstrated that human tooth enamel is capable of storing information on the impact of radiation on the body and this information can be obtained by the electron spin resonance (ESR) method. Two ESR methods now exist for determining the absorbed dose. each of which is reviewed, but a fundamentally new approach is proposed for discriminating the signal of the radiation-induced center from the experimental total ESR spectrum of tooth enamel and this is demonstrated to be superior to presently used variants. An analysis was made of the spin-lattice relaxation properties of the superposed radiation-induced and phonon signals of ESR in tooth enamel samples. It was established that these paramagnetic centers differ with respect to saturation half-power and the effective saturation factor. The new approach makes it possible to determine the intensity of the radiation-induced signal in any tooth enamel sample, including in milk teeth. The results of this comparison are given in a table. The results of the different approaches are roughly identical, but the time expenditures are completely different. The proposed method, with an identical accuracy, in this respect is preferable to the method based on additional irradiation of tooth enamel samples in vitro. Figures 8; references 9: 4 Russian, 5 Western.

Engineering Transgenic Potato Plants Resistant to Potato Virus Y

957A0060A Moscow MOLEKULYARNAYA BIOLOGIYA in Russian Vol 28 No 5 Sep-Oct 94 (manuscript received 17 Dec 93) pp 10 02-1008

[Article by M.A. Sokolova, M.M. Pugin, O.A. Shulga, K.G. Skryabin, Bioengineering Center, Russian Academy of Sciences, Moscow; UDC 578.864.1]

[FBIS Abstract] One promising means of producing virus-resistant plants is the creation of transgenic plants which synthesize the coat proteins of viruses, their mRNA, or antisense RNA. Potato virus Y is one of the most pathogenic phytoviruses. Transgenic potato plants (Belorusskiy-3 variety) were obtained which accumulated the coat protein (CP) of potato virus Y (PVY), or expressed plus- or minus-sense CP transcripts and accumulated no CP. Immunoenzymati c analysis was used to test the sensitivity of the resulting transgenic plants to viral infection. Plants with a low level of PVY CP RNA expression or undetectable CP were better protected than those accumulating PVY CP or antisense PVY RNA. Resistance is thus based on the presence of PVY CP RNA,and not accumulation of the virus CP. Figures 3; references 19: 1 Russian, 18 Western.

Analysis of Oligonucleotide-Binding Site on Immunoglobulin Molecule

957A0060B Moscow MOLEKULYARNAYA BIOLOGIYA in Russian Vol 28 No 5 Sep-Oct 94 (manuscript received 21 Mar 94) pp 1106-1112

[Article by L.V. Pautova, P.P. Laktionov, Ye. Yu. Rykova, L.A. Yakubov, V. V. Vlasov, Novosibirsk Institute of Bio-Organic Chemistry, Siberian Division, Russian Academy of Sciences, Novosibirsk; UDC 577.123]

[FBIS Abstract] Study of the interaction of oligonucleotides with proteins in vivo is important in light of the development of new biologically active substances such as oligonucleotides and polymer nucleic acids. This paper studies the interaction of class G immunoglobulins with oligonucleotides. The interaction involved rea ctive derivatives of $p(T)_{16}$ bearing a 4-[(N-2-chloroethyl-N-methyl) amino]benzylamine residue at the 5'-terminal phosphate. Modified immunoglobulins were subjected to enzymatic cleaving into Fc and Fab fragments and chemical hydrolysis of the methionine residues. Analysis of the peptide fragments that were formed showed that interaction with oligonucleotides occurs in the antigen-binding Fab fragment of immunoglobulin in the section which corresponds to the N-terminal peptide of the light chain, 178 amino acid residues long. This agrees with data we obtained earlier that the formation of a complex with a specific antigen prevents interaction of immunoglobulin with oligonucleotide. However, covalent binding of an oligonucleoti de with a Fab fragment does not prevent antigen-antibody interaction. Monoclonal Fab fragments modified with $ClRCH_{2NHp(T)_{16}}$ bind with a specific antigen, human

myoglobin, in affine chromatography. Further study of this inter action will be significant for predicting the fate of oligonucleotides invivo when used as therapeutic substances. Figures 3 ; references 15: 8 Russian, 7 Western.

Subregional Location of Recombinant Cosmids Containing Microsatellite Sequences on Human Chromosome 13

957A0060C Moscow MOLEKULYARNAYA BIOLOGIYA in Russian Vol 28 No 5 Sep-Oct 94 (manuscript received 20 Dec 93; after revision 21 Apr 94) pp 1149-1157

[Article by M.V. Kost, L.I. Fedorova, B.I . Kapanadze, N.K Yankovskiy, A.B. Zelenin; V.A. Engelgardt Institute of Molecular Biology, Russian Academy of Sciences, Moscow; UDC 577.212.3]

[FBIS Abstract] One goal of the Human Genome project is to map highly polymorphic molecular-genetic markers of the human genome. Subregional localization of DNA fragments bearing microsatellites is of great interest because the overwhelming majority of the most highly polymorphic markers are based on microsatellite sequences. This paper describes the first stage of creating molecular-genetic markers, subregional localization of sequences containing microsatellite sequences on human chromosome 13. In-situ fluorescent hybridization is used to determine the subregional location of 24 recombinant cosmids on human chromosomes. Fifteen clones are found in only one chromosome; thirteen are on chromosome 13, one on chromosome 1 and one on chromosome 11. Nine cosmids were hybridized with the nuclear organizer region (NOR). These clones gave a signal from the NOR region of chromosome 13, as well as other chromosomes containing ribosome DNA genes. The cosmid probes which contained microsatellite sequences with the motifs GACA, GACT, GATG, TCC, and CA were selected from the clone library of human chromosome 13. A total of 21 probes contained microsatellite sequences with motifs GACA, GACT, GATG, TCC, and CA. Three probes did not contain these sequences. Each of nine clones in the NOR contain microsatellites with the motifs GACA an d TCC. Among fifteen clones which gave unique signals, there were nine clones which contain microsatellites with the motif G ACT. Microsatellites with GATG, TCC, and CA were each found in one clone. These clones are the basis for obtaining highly p olymorphic molecular-genetic markers for human chromosome 13 and detailed genetic mapping. Figures 5; table 1; references 19: 4 Russian, 15 Western.

Expression of a Partially Modified Gene for -Endotoxin from Bacillus thuringiensis var. tenebrionis in Transgenic Potato Plants

957A0060D Moscow MOLEKULYARNAYA BIOLOGIYA in Russian Vol 28 No 5 Sep-Oct 94 (manuscript received 10 Feb 94; after revision 13 May 94) pp 1166-1175

[Article by I. V. Gulina, O. A. Shulga, M. V. Mironov, Ye. V. Rebenkova, A.S. Krayev, G.Ye. Pozmogova, G.A. Yakovleva, K.G. Skryabin, Bioengineering Center, Russian Academy of Sciences, Moscow; UDC 577.214.622]

[FBIS Abstract] δ-endotoxins are crystalline proteins formed in Bacillus thuringiensis that act as an insecticide. There are 60 known genes coding 26 δ-endotoxins. A δ-endotoxin gene from Bacillus thuringiensis var. tenebrionis was partially modified. On the 5' end 16 nucleotide were replaced in a 66 nucleotide long section, and on the 3' end three nucleotides were replaced in an 18 nucleotide long section. The altered codons were optimized for plants. A cassette was obtained for expression of this gene in plants. The binary vector pMON505, which contains the modified gene (Bt77), was transferred into three agrobacterium strains containing different helper disarmed Ti-plasmids, LBA4404, A281, CBE21. CBE21 was the most effective in producing Bt77. The strains were used to transform a model variety of potato, Desiree, to determine the effectiveness of the transformation by each individual strain.

Moreover, transformants were obtained for the Temp, Granat, and Resy varieties. The presence of the sequence for the Bt77 gene in genome DNA isolated from regenerant plants was confirmed by a polymerase chain reaction. Analysis of the expression of a foreign gene in transgenic plants showed that the level of synthesized protein was 0.005-0.02% of the total protein. Biological testing of transgenic plants revealed substantial protection against the Colorado beetle at all stages of development compared with control nontransformed potato plants. Toxicity was specific to the Colorado beetle. Figures 8; references 42 : 6 Russian, 36 Western.

New Method of Covalent Immobilization of Oligodeoxyribonucleotides on Nylon Membranes for Hybridization with Nucleic Acids

957A0060E Moscow MOLEKULYARNAYA BIOLOGIYA in Russian Vol 28 No 5 Sep-Oct 94 (manuscript received 21 Apr 94) pp 1176-1182

[Article by M.G. Ivanovskaya, I.A. Kozlov, I.V. Lebedeva, Z.A. Shabarova, Belozerskiy Scientific Research Institute of Physico-Chemical Biology, Lomonosov Moscow State University, Moscow; UDC 577.113.6/577.113.7]

[FBIS Abstract] An effective method was developed for covalent immobilization of oligodioxyribonucleotides on commercial nylon membranes containing surface amino groups. The surface groups act as anchor groups to immobile oligonucleotides. The oligonucleotides are attached to the membrane by spacer groups between the oligonucleotide and the membrane. The spacer is reduced glutathione, which is attached to the terminal phosphate of the oligonuc leotide prior to immobilization. The oligonucleotide is bound to the membrane via the terminal group to maximize use of the complementary properties of the oligonucleotide in hybridization. Introduction of a spacer group between the membrane and the probe increases hybridization effectiveness. Membranes containing covalently immobilized 23-membered oligonucleotide were tested in hybridization of a complementary oligonucleotide with single-stranded DNA of bacteriophage M13. The immobilization method is simple and easily reproducible. The membranes may be used not only for hybridization analysis, but also to isolate individual nucleic acids and proteins which recognize nucleotide sequences, as well as in sense biotechnology. Figures 5; references 6: 2 Russian, 4 Western.

Synthesis and Antibacterial Activity of New Derivatives of 1,4-Di-N-oxides of Quinoxaline

957A0098A Moscow KHIMIKO-FARMATSEVTICHESKIY ZHURNAL in Russian Vol 28 No 1 Jan 94 (manuscript received 17 Jun 93) pp 15-17

[Article by R.G. Glushkov, T.I. Vozyakova, Ye.V. Adamskaya, S.A. Aleynikova, T.P. Radkevich, L.D. Shepilova, Ye.N. Padeyskaya, and T.A. Guskova, Chemicopharmaceutical Institute imeni S. Ordzhonikidze, TsKhLS-VNIKhFI (not further identified), Moscow; UDC 615.281:547.863.1].012.1.07]

[FBIS Abstract] A number of 1,4-di-N-oxides of quinoxaline, specifically, preparations of quinoxaline and dioxidine and analogues thereof that contain fluorine and chlorine atoms in position 6, are known to possess high antibacterial activity. In view of this fact, a number of 1,4-di-N-oxides of quinoxalines containing chlorine or fluorine atoms in positions 6 and 7 were synthesized and studied to gain greater insight regarding their antibacterial activity. First, 5,6-dichlorobenzofuroxan and 5-chloro-6-(4'-methylpiperazinyl-1')benzofuroxan ($C_{11}H_{13}ClN_4O_2$) were synthesized by oxidation of 4,5-substituted nitoranilines with sodium hypochlorite in an aqueous-alcohol-alkaline medium. Two additional benzofuroxans were synthesized by azide pyrolysis. Then the first five benzofuroxans synthesized were reacted with methyl ethyl ketone in the presence of ammonia or anamine. The resultant 1,4-di-N-oxides of quinoxaline were bromated, and the resultant bisbromomethyl derivatives were reacted with triethylammonium acetate to form four diacetates. 5-Chloro-6-(4'-methylpiperazinyl-1')benzofuroxan was reacted with the sodium salt of oxalacetic ether to synthesize the 1,4-di-N-oxide of diethyl ether 6-chloro-7-(4'-methylpoperazinyl-1')quinoxaline-2,3-dicarbonic acid. The corresponding acid ($C_{15}H_{15}ClN_4O_6$) was synthesized by alkaline hydrolysis. The structures of all of the newly synthesized compounds were confirmed by nuclear magnetic resonance and mass spectrometry. The antibacterial and antifungal activity of the newly synthesized compounds was studied in vitro by the method of two series of dilutions in liquid nutrient medium with four bacterial strains and three strain of fungus. Eight of the newly synthesized compounds were also tested in vivo on mice in which model septicemias were induced by *Pseudomonas aeruginosa* 165, *Salmonella typhi* 4446, and *Staphylococcus aureus* 178. Four of the compounds, i.e., $C_{10}H_{10}ClN_3O_3$, $C_6H_2ClFN_2O_2$, $C_8H_7ClN_2O_3$, and $C_{14}H_{14}Br_2ClN_3O_3$, manifested marked activity (minimal inhibitory concentration [MIC], 2-7.8 μg/ml) against gram-positive bacteria (*S. aureus* and *Bacillus subtilis*) and pathogenic fungi in vitro. In addition, two of the compounds, i.e., $C_6H_{12}F_2N_2O_2$ and $C_{10}H_6Br_2F_2N_2O_2$, were active only against fungi. Two other compounds were active against gram-positive bacteria, and an additional two compounds were moderately active against *S. aureus*, *B. subtilis*, and fungi. None of the compounds inhibited the growth of gram-negative bacteria, with the exception of two compounds ($C_{11}H_{13}ClN_4O_2$ and $C_6H_{12}F_2N_2O_2$) that exhibited moderate activity against *Escherichia coli* in concentrations of 15.6-62.5 μg/ml. In the in vivo studies, the compounds either manifested a very weak therapeutic effect or else were totally inadequate against the septicemias induced by the three aforementioned bacterial strains. Tables 2; references 5: 4 Russian, 1 Western.

Synthesis and Psychotropic Activity of 8-Benzylamino-1,2-dihydro-10-o-2,2,5-trimethyl-4H-pyrano-[4'3':4,5]pyrido[3,2-e]-1,3-thiazine

957A0098B Moscow
KHIMIKO-FARMATSEVTICHESKIY ZHURNAL
in Russian Vol 28 No 1 Jan 94 (manuscript received 24 Dec 92) pp 20-22

[Article by Ye.G. Paronikyan, S.N. Sirakanyan, A.S. Noravyan, E.M. Arazanunts, R.G. Paronikyan, I.S. Sarkisyan, and N.Ye. Akopyan, Fine Organic Chemistry Institute imeni A.L. Mindzhoyan, Armenian Academy of Sciences, Yerevan; UDC 547.816.83.86]

[FBIS Abstract] In an effort to find new biologically active compounds, researchers synthesized a new heterocyclic system, i.e., 1,2-dihydro-4H-pyrano[4'3':4,5]pyrano[3,2-e]-1,3-thiazine, and studied its psychotropic properties. As a starting compound, researchers used the previously described compound 3,4-dihydro-5-carbamoyl-3,3,8-trimethyl-6-chloro-1H-pyrano[3,4-c] pyridine (I). By reacting the amide of I with sodium nitrate in the presence of hydrochloric acid, they produced an acid (II) that they then transformed into an acid chloride (III). Next, the new acid chloride III was processed with ammonium rhodanide and then with benzylamine without separating the isothiocyanate (IV). As a result, N-benzyl-N'-5-(3,4-dihydro-3,3,8-trimethyl-6-chloro-1H-pyroano[3,4-c]pyridinoyl)thiourea (V) was formed and then cyclized as described elsewhere into the desired [4',3':4,5]pyrido[3,2-e]1,3-thiazine (VI). Compound VI was injected intraperitoneally into laboratory mice in doses of 10, 20, 40, 80, and 100 mg/kg of body weight after having been dissolved in a mixture of twin-40 and distilled water. The mice were examined 1, 3, and 5 hours after the injections. The pharmacologic properties of compound VI were assessed on the basis of the following indicators: 1) effect on spontaneous motor activity and skin temperature; 2) effect on hexanol-induced sleep; 3) effect on apomorphine hypothermia; 4) effect on hyperkinesia induced by injection of 5-oxytryptophan [5-OTP]; 5) effect on spasms induced by electric shock or injection of Corazol (pentylenetetrazol), strychnine, picrotoxin, or thiosemicarbazide; and 6) acute toxicity. In the doses studied, compound VI suppressed spontaneous motor activity and reduced skin temperature somewhat (on average, by 1.5°C for 1-2 hours). Increasing the dose of compound VI to 100 mg/kg resulted in an increase in hypothermia (-2.0°C) and some suppression of motor activity. No blepharoptosis or catalepsy was noted. In contrast, aminazine in a dose of 5 mg/kg caused significant hypothermia (-7.6°C), prostration, and total slackening of muscle tone. Aminazine's effects persisted for more than 5 hours. Compound VI doubled hexanol's soporific effect, whereas aminazine in doses as low as 5 mg/kg tripled hexanol's soporific effect. In a dose of 100 mg/kg, compound VI intensified apomorphine hypothermia by 1.4°C on average for 3 hours after injection of the apomorphine (whereas at a dose of 5 mg/kg, aminazine intensified apomorphine hypothermia by 2.8°C). Also in a dose of 100 mg/kg, compound VI counteracted the hyperkinesia that is induced in mice by injection of 200 mg/kg 5-OTP. Compound VI also prevented clonic spasms induced by injection of 90 mg/kg Corazol and significantly lengthened the latent period of the appearance of strychnine-induced convulsions. Thiosemicarbazide injected into mice subcutaneously in a dose of 18 mg/kg caused tonic-clonic spasms that in all cases culminated in tonic extension. Prior injection of compound VI in a dose of 200 mg/kg significantly lengthened the latent period of the said spasms, whereas Zarontin (ethosuximide) in doses of 200-300 mg/kg had no effect on the time of onset of thiosemicarbazide-induced spasms. Like Zarontin, compound VI increased the latent period of picrotoxin-induced spasms somewhat but not statistically significantly. Compound VI proved ineffective as an antagonist of maximum electric shock. Its median lethal dose [LD_{50}] in mice was calculated as 1,000 mg/kg (versus aminazine's LD_{50} of 74 mg/kg). Figure 1, tables 2; references 8: 4 Russian, 4 Western.

Synthesis of Bis(aminothiazolyl)methanes and Their Inhibiting Effect on Acetylcholinesterase

957A0099A Moscow
KHIMIKO-FARMATSEVTICHESKIY ZHURNAL
in Russian Vol 28 No 2 Feb 94 (manuscript received 19 Mar 93) pp 9-10

[Article by O.V. Litvinov, A.A. Safonova, S.N. Chalaya, and V.G. Kharchenko, Saratov University, Saratov Chemistry Scientific Research Institute; UDC 547.422.5.829.749.04]

[FBIS Abstract] Five bis(aminothiazolyl)methanes and their hydrochlorides (10 compounds in all) were synthesized and studied to determine their inhibiting effect on acetylcholinesterase. Two of the salts were very hygroscopic and were therefore not isolated in analytically pure form. The activity of the remaining compounds and salts were studied by potentiometric titration with acetylcholinesterase derived from human erythrocytes and with acetylcholine iodide serving as a substrate. As expected, the dihydrochlorides of bis(aminothiazolyl-)methanes possessed a greater inhibiting effect than did the corresponding free bases. The only exception was the compound $C_{19}H_{16}N_4S_2$, which possessed a higher acetylcholinesterase-inhibiting activity than did its salt. Among the dihydrochlorides studied, two, i.e., $C_{11}H_{24}N_4S_2$ and $C_{23}H_{24}N_4S_2$ (pI_{50} = 4.7) had an especially good acetylcholinesterase-inhibiting activity. This activity was attributed to a combination of electronic and steric factors facilitating their reaction with the cholinesterase's active centers to a greater degree than occurred in the case of the other three hydrochlorides studied. The inhibiting activity of the latter hydrochlorides ranged from pI_{50} = 3.3 to 4.6, and that of the corresponding bases ranged from pI_{50} = 3.5 to 4.3. The promise of systematic investigation of bis(aminothiazolyl)methanes as cholinesterase inhibitors was thus confirmed. Tables 2; references 2 (Russian).

Sorption of Cesium, Strontium, Lead, and Cadmium Ions by Fibrous Carbonic Sorbents

957A0099B Moscow
KHIMIKO-FARMATSEVTICHESKIY ZHURNAL
in Russian Vol 28 No 2 Feb 94 (manuscript received 17 Nov 92) pp 16-19

[Article by A.A. Morozova, I.L. Shashkova, Ye.A. Prodan, and Yu.V. Lobovich, General and Inorganic Chemistry Institute, Byelarus Academy of Sciences, Minsk; UDC 615.246.2:546.26/.03:/615.38.015.2: 615.246.2]

[FBIS Abstract] The enterosorbent Vaulen is an enterosorbent based on based on raw hydrated cellulose materials. Vaulen and an ion-exchange modification thereof (designated VUI) were tested to determine their effectiveness in the sorption of Cs, Sr, Pb, and Cd ions from diluted aqueous solutions of the respective salts. To increase its absorbency with respect to Cs ions, the sorbent was chemically modified by potassium ferrocyanide and iron. Their effectiveness of the ion-exchange version of Vaulen and its ferrocyanide-modified form version (designated VUI-F) as sorbents of Cs^+, Sr^{2+}, Pb^{2+}, and Cd^{2+} from nitrate solutions in concentrations ranging from 0.001 to 0.02 N under static conditions was tested at room temperature by adding weighted samples (about 0.2 g) of the two sorbents to a 25-ml solution of the nitrate of the respective metal and stirring it intermittently over the course of 1 hour. Quantitative determination of Cs and Sr was made with an S-115-M-1 atomic absorption spectrophotometer, and Pb and Cd were determined with a Plasma-100 spectrometer. Whether used in hydrogen, sodium, and potassium form and whether used in braid or fabric form, VUI proved to be an effective sorbent of Cs^+ from aqueous solutions. In cases of a low initial concentration of solution (0.001 N), sorption of Cs from solution by VUI reached 90 percent. Sorption of Cs^+ from more concentrated (0.01 N) solutions averaged 45 mg/g, which corresponds to 25-30 percent extraction. Sorption on the modified form of Vaulen, i.e., VUI-F, at the said concentration amounted to 84 mg/g, which corresponds to a 54 percent extraction of Cs, or in other words, twice than of the nonmodified form of Vaulen. VUI was incapable of sorption of potassium ferrocyanide and iron from colloidal solutions. Unlike VUI, Vaulen in its original form could be modified by ferrocyanide compounds by each of three different methods and could thus be made capable of absorbing potassium ferrocyanide and iron from colloidal solutions and from a dispersion of the water-insoluble preparation Ferrotsin [transliteration]. However, it could not be made to absorb more than 3-4 percent of the ferrocyanide present in solution. The fibrous carbonic sorbent UUT and "nonwoven" carbonic sorbent AUT-M were similarly shown to be good absorbers of Pb ions. The ion-exchange forms were found to be good absorbers of Cr ions. Sorption of Cd ions from a 0.02 N solution of $Cd(NO_3)_2$ did not exceed 22-27 percent. The enterosorbent Vaulen and its modified forms have been demonstrated to possess properties that make them promising for use in creating therapeutic and prophylactic agents intended for sorption detoxication of the body under adverse radioecologic conditions. Figures 2, tables 3; references 10: 9 Russian, 1 Western.

Synthesis and Radioprotective Effect of Derivatives of Thiadiazoles, Thiadizolines, Dithiolidenes, and Their Selenium Analogues

957A0099C Moscow
KHIMIKO-FARMATSEVTICHESKIY ZHURNAL
in Russian Vol 28 No 2 Feb 94 (manuscript received 3 Dec 92) pp 19-22

[Article by L.L. Petrova, L.V. Trufanova, M.L. Petrov, M.A. Abramov, N.I. Zmitrovich, and N.A. Terentyeva, Krasnoyarsk Medical Institute and Technological Institute, St. Petersburg; UDC 615.849.015.25.012.1 +615.849,0.15.25.076.9]

[FBIS Abstract] The following compounds were synthesized and studied to determine their radioprotective effect and toxicity: $C_8H_5BrN_2S$ (I), $C_8H_5ClN_2S$ (II), $C_8H_5ClN_2Se$ (III), $C_{22}H_{25}N_3OS$ (IV), $C_{22}H_{25}N_3OSe$ (V), $C_{21}H_{23}N_3O_2Se$ (VI), $C_{17}H_{14}N_2OS$ (VII), $C_{17}H_{14}N_2OSe$ (VII), $C_{16}H_{10}Cl_2S_2$ (IX), $C_{18}H_{16}S_2$ (X), and $C_{18}H_{16}Se_2$ (XI). The studies were performed on $F_1(CBAxC_{57}B1)$ mice of both sexes (weight, 18-22 g each) that were fed a standard diet. Each dose of each compound was tested on five mice, and each mouse was observed for 3 days. All of the compounds were water insoluble and therefore used in the form of suspensions in a 1 percent solution of twin-80. The mice used in the experiments measuring the radioprotective effects of compounds III, IV, VII-IX, and XI were irradiated with 850 rad by an RUM-1 x-ray device at a dose rate of 450 rad/min. In the case of the compounds determined to be toxic, mice were administered intraperitoneal [IP] injections of the various compounds in doses of ⅛ and ½ the dose determined to be lethal to 16 percent of the mice [LD_{16}]. In the case of the compounds determined to be nontoxic, the mice received IP injections of compound in doses of 50 and 500 μmol/kg. Each dose was tested by injecting 10 mice 15 minutes before the irradiation sessions. Two control groups of mice were used. One group of controls (n= 6) were irradiated after receiving a physiologic solution or a 1 percent solution of twin. The second group of controls (n = 6) were irradiated after having received 10 mg/kg of the well-known radioprotector mesaton (phenylephrine hydrochloride). Compounds I, IV, and IX were not toxic when used in concentrations of 100 to 1,000 mg/kg. Compounds VII, VIII, IX, and X were not found to be toxic either but could only be tested in concentrations up to 500 mg/kg because they formed extremely thick suspensions in higher concentrations. The selenium analogues were found to be highly toxic. The median lethal dose [LD_{50}] of drugs II, III, V, VI, and XI were as follows (mg/kg): II, 390; III, 51.5; V, 345; VI, 253; and XI, 1,012. Only compound IX, i.e., 2-n-chlorobenzylidene-4-n-chlorophenyl-1,3-dithiol, had a radioprotective effect: It contributed to a 30 percent survival rate among irradiated mice when administered in a dose of 168 mg/kg. Tables 3; references 9: 5 Russian, 4 Western.

Synthesis and Antiviral Activity of 1-[2-(Allyloxy)ethoxymethyl]-1- and 1-[1,3-Di(allyloxy)-2-propoxymethyl]pyrimidines

957A0099D Moscow
KHIMIKO-FARMATSEVTICHESKIY ZHURNAL
in Russian Vol 28 No 2 Feb 94 (manuscript received 21 Jul 92) pp 26-28

[Article by M.S. Novikov, A.A. Ozerov, A.K. Brel, Ye.I. Boreko, L.V. Korobchenko, and G.V. Vladyko, Pharmacology Scientific Research Institute, Volgograd Medical Institute, Russian Federation Ministry of Health, and Byelarus Epidemiology and Microbiology Scientific Research Institute, Minsk; UDC 547.854.4+854.81 +857.7: 615.281]

[FBIS Abstract] In an effort to find new potential antiviral agents, researchers synthesized and studied the antiviral activity of 1-[2-(allyloxy)ethoxymethyl]-1- and 1-[1,3-di(allyloxy)-2-propoxymethyl] derivatives of pyrimidine bases that are O-allylated analogues of the two familiar acyclic nucleoside analogues acyclovir and ganciclovir. The effectiveness of newly synthesized compounds against herpes simplex virus type 1 [HSV-1], vaccinia virus, classic fowl (avian) plague, vesicular stomatitis, Venezuelan equine encephalomyelitis, respiratory syncytial virus, the enterovirus ECHO-6 echo virus, and rotavirus was evaluated on tissue cultures by the screening test method and by reduction of blasts under an agar coating. Of the 14 newly synthesized unsaturated acyclonucleosides, 5 manifested some degree of antiviral activity. The compound $C_{11}H_{16}N_2O_4$ manifested rather weak activity against classic fowl plague. The compound $C_{10}H_{13}N_2O_4$ manifested weak activity against rotavirus, and the compounds $C_{10}H_{13}BrN_2O_4$ and $C_{15}H_{22}N_2O_5$ were moderately active against rotavirus. The compound $C_{15}H_{21}BrN_2O_5$ manifested marked antiviral activity against vaccinia virus and was also active against classic fowl plague and ECHO-6. Because the three cytosine derivatives, i.e., $C_{10}H_{15}N_3O_3$, $C_{10}H_{14}BrN_3O_3$, and $C_{14}H_{21}N_3O_4$ demonstrated no antiviral activity whatsoever, it was concluded that the possible biologic degradation of the said compounds does not include initial deamination or O-dealkylation inasmuch as the said processes would have resulted in more active metabolism products. None of the newly synthesized compounds manifested any noticeable activity against HSV-1. Tables 2; references 22: 5 Russian, 17 Western.

Mathematical Modeling of Conduction Anesthesia of Series of Phenylpropiophenones

957A0099E Moscow
KHIMIKO-FARMATSEVTICHESKIY ZHURNAL
in Russian Vol 28 No 2 Feb 94 (manuscript received 29 Sep 92) pp 28-32

[Article by P.P. Isayev and V.A. Nikolayevskiy, Voronezh Pedagogical Institute and Voronezh Medical Institute imeni N.N. Burdenko; UDC 615.216.2: 541.66+541.69.11]

[FBIS Abstract] A reliable, well-established database regarding conduction anesthesia that has been developed on the basis of direct experiments involving laboratory animals exists for the series *o*-(β,-N,N-diethylaminoethoxy)-β-phenylpropiophenone hydrochloride [Etaphon]. The said database was used to construct a heuristic model of the molecular interaction of Etaphon and its derivatives with the surface of a biological nerve membrane and thereby establish a correlation linking the minimum blocking concentration of Etaphon and its derivatives with the energy of their intermolecular interaction modified by molar refraction of the compound. According to the model, the biomembrane is an infinite conducting surface and anesthesia depends on adsorption of the drug molecule on the surface of the nerve fiber's biomembrane as dictated by two competing factors: 1) the dispersion energy of the drug molecule's attraction to the biomembrane and 2) the energy of the anesthetic's confinement in the intercellular solution (the dispersion energy of the interaction of the drug molecule and water). The model's validity was evaluated by experiments in which conduction anesthesia was studied in 625 frogs by exposing their sciatic nerve to a solution of Etaphon (in concentrations ranging from 0.0625 to 0.5 percent). The experiments established that conduction anesthesia by Etaphon is achieved in one-fifth to one-sixth the time required when trimecaine is used as the anesthetic and that the most effective concentrations of phenylpropiophenone and its derivatives in conduction anesthesia are 0.25 and 0.5 percent solutions (with the minimum effective concentration of Etaphon being a 0.1 percent solution). The results obtained when the newly developed mathematical model was used to predict Etaphon's anesthetizing activity were in good agreement with the results of the experiments performed on the frogs. This consistency between the experimental and calculated results, coupled with a thorough statistical analysis of the mathematical model, led to the conclusion that the model is indeed valid and

useful as a prognostic tool. All of the programs for calculating molar refractions based on molecule structure and for performing a statistical analysis of the dependence of a drug's physiologic activity on its physicochemical parameters are written in BASIC and may be implemented on an IBM AT/286 PC. Figure 1, table 1; references 14: 11 Russian, 3 Western.

Effect of Sterilization on Selectivity and Throughput of Microfiltration Membranes Made of Fluoroplastic-42 and Cellulose Derivatives

957A0099F Moscow
KHIMIKO-FARMATSEVTICHESKIY ZHURNAL
in Russian Vol 28 No 2 Feb 94 (manuscript received 2 Jun 92) pp 44-49

[Article by G.B. Bochkova, A.S. Yushin, and O.N. Parfentyeva, Epidemiology and Microbiology Scientific Research Institute, Nizhniy Novgorod; UDC 66.067.12-541.6:614.48]

[FBIS Abstract] Studies have indicated the promise of using polymer microfiltration membranes in various applications, including sterilization filtration of drugs and isolation and concentration of microorganisms for laboratory and analytic purposes. For this reason, the effectiveness of sterilization on the selectivity and throughput of microfiltration membranes made of fluoroplastic-42 and cellulose derivatives was examined. The following membranes were studied: series-produced hydrophobic (MFFK No. 3) and hydrophilic (MFFK No. 34) Validipor membranes, which are manufactured by the Polimersintez Scientific Production Association and based on fluoroplastic-42 applied onto nonwoven polypropylene; MFTs No. 3, MFA-EM No. 2, MFAS-OS No. 3, and MFA-MA No. 5 membranes, which are based on cellulose and its acetates and manufactured by the Tasma Production Association; and membranes of the HAWP type, which are made from a mixture of nitrocellulose and cellulose acetate and manufactured by the firm Millipore. Permeability and selectivity were determined by using distilled water with 47-mm-diameter membranes at a pressure of 0.05 MPa and by using an LAM-2 laser microparticle analyzer to count the number of particles. Steam sterilization was conducted at 121°C for 45 minutes, and chemical sterilization was performed in a 6 percent solution of hydrogen peroxide and 2 percent solution of formaldehyde for 6 and 24 hours, respectively. Ultraviolet irradiation was performed with three BUV-15 bactericidic lamps. Each side of the membrane was irradiated for 30 minutes from a distance of 50 cm from the source. Chemical sterilization had no effect on the minimum retentivity of most of the membranes. The only exception was the HAWP membrane. Its selective properties diminished sharply when it was treated with a formaldehyde solution; specifically, its particle extraction efficiency decreased by 43 percent. After the cellulose acetate membranes had been treated with hydrogen peroxide, particles measuring 3 μm or more began appearing in their filtrate. The particles were concluded to be pieces of the membrane itself that had split off from the membrane's matrix as a result of oxidation of the polymer's acetyl groups. Hydrogen peroxide sterilization of the membranes made of regenerated cellulose (MFTs No. 3), on the other hand, helped equalize its selectivity plateau. Chemical sterilization did not induce any significant changes in the fluoroplastic membranes. After chemical sterilization, the cellulose ether membranes' permeability increased by 11-33 percent. After they were rinsed off, the said membranes' permeability increased by 25-65 percent. The permeability of the HAWP membranes more than tripled after chemical sterilization. Chemical sterilization also had adverse effects on the throughput of the membranes made of regenerated cellulose. The least harsh sterilization method proved to be sterilization by ultraviolet [UV] light. The only adverse effect of UV sterilization noted was a slight decrease in the selectivity of the MFTs No. 3 and HAWP membranes. Steam sterilization proved harshest for the cellulose membranes and those made of either cellulose acetate or nitrocellulose membranes; it reduced their throughput by 16-116 and 12-70 percent, respectively. Autoclaving improved the selectivity of the hydrophilic membranes by 20-50 percent and increased their particle extraction efficiency by 6-12 percent. In general, UV sterilization was recommended as the safest membrane sterilization method. Figures 3, tables 4; references 13: 11 Russian, 2 Western.

Effect of Radiation Sterilization on Structural and Filtration Characteristics of Polymer Filtration Membranes

957A0099G Moscow
KHIMIKO-FARMATSEVTICHESKIY ZHURNAL
in Russian Vol 28 No 2 Feb 94 (manuscript received 2 Jun 92) pp 49-52

[Article by G.B. Bochkova and A.S. Yushin, Epidemiology and Microbiology Scientific Research Institute, Nizhniy Novgorod; UDC 66.067.12-541.6:614.48]

[FBIS Abstract] Because polymer membranes are widely used in the sterilization of biologically active fluids, a study examined the effects of radiation sterilization on their structural and filtration characteristics. Various types of domestic and foreign polymer membranes were studied. The following Vladipor membranes produced by the Tasma Production Association and Polimersintez Scientific Production Association were studied: membranes produced from cellulose and cellulose acetates (MFTs No. 2, MFTs No. 3, MFA-A No. 1, MFA-MA No. 1, MFA-EM No. 1, and MFAS-OS No. 1); hydrophobic (MFFK No.1, No. 2, No. 24, and No. 14) and hydrophilic (MFFK No. 2) membranes made of fluoroplastic-42 on a polypropylene substrate; and a membrane (UPM-67) made of polysulfone on a nonwoven lavsan substrate. Also tested for their ability to withstand radiation sterilization were the following membranes: MIFIL 1-2-0.2 membranes made of kapron at the experimental

laboratory of the Khiyu Kalur collective fishery; YaMR-0.12 membranes made of lavsan at a laboratory at the Joint Institute for Nuclear Research; and foreign membranes made of mixtures of nitrocellulose and cellulose acetate (the Millipore HAWP and the Ultipore No. 66 NRG). Each membrane's selectivity and permeability were determined in distilled water, and an LAM-2 laser microparticle analyzer was used to count the number of particles. A JSM-50A scanning electron microscope and Videolab 2.2 image processing system were used to study the structure of each membrane. Three BUV-15 bactericidic lamps were used for ultraviolet [UV] radiation sterilization of sample membranes for 30 minutes at a distance of 50 cm from the source. The various membranes' ability to withstand γ-radiation was tested at a γ-irradiation dose of 2.5 kGy. UV radiation had no significant effects on the throughput of any of the membranes. γ-Radiation increased the throughput of the MIFIL membranes by 16 percent and that of the YaMF membranes by 38 percent; however, it reduced the throughput of the MFA-A membranes by 19 percent in the absence of any significant changes in pore size or "bubble point." Moreover, the porosity of the MIFIL membranes decreased by 3 to 10 percent, and the pore size of their sheared surface decreased by 0.1 μm. γ-Radiation increased the permeability of the kapron and lavsan microfilters, increased the throughput of the cellulose acetate membranes (MFA-A), and increased the permeability of the polyamide membranes. After γ-irradiation, all of the membranes underwent a 2.5-13.3 percent change in structural anisotropy: It increased in the case of MFTs and MFA-A membranes and decreased in the case of MIFIL membranes. γ-Irradiation resulted in the development of diffusion air flows through the HAWP and MFFK microfilters, which was taken as evidence of membrane destruction and the development of microflaws. Overall, UV irradiation proved much less damaging to the polymer membranes studied than did γ-irradiation and thus appears to be the better way of sterilizing polymer membranes than either γ-irradiation or the popular method of steam sterilization. Figures 3, tables 4; references 8 (Russian).

— Bracketed indicators before the first sentence of each item describe the way in which the material was processed by FBIS.

— Headlines and all bracketed explanatory notes are supplied by FBIS.

— Personal and place names are rendered in accordance with the decisions of the U.S. Board on Geographic Names as adapted by FBIS. Unverified names in radio and television material appear in parentheses and are spelled phonetically; words and phrases in parentheses preceded by a question mark are unclear in the original and deduced from context.

SUBSCRIPTION INFORMATION

U.S. Government Customers

For a list of FBIS products, to subscribe to an FBIS publication, or to indicate a change of address contact:

FBIS
P.O. Box 2604
Washington, DC 20013-2604
Telephone: (202) 338-6735
FAX: (703) 733-6042

Non-Government Customers

Subscriptions are available from the National Technical Information Service:

NTIS
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 487-4630
FAX: (703) 321-8547

New subscribers should expect a 30-day delay in receipt of the first issue.

END OF FICHE

DATE FILMED

29 MAR 1995